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SUPERINTENDENTS' ROUND TABLE DISCUSSION[1]

INSTALLATION AND CARE OF CENTRIFUGAL PUMPS

WM. W. BRUSH:[2] It might be interesting to have me tell you about some experiences with an installation we had to make in a hurry, about three years ago. We found that we were short of pump capacity and to meet the situation as quickly as we could we made a contract to have three centrifugal units installed. We could not get a massive foundation, so these pumps and motors were mounted on I-beams that were placed across a chamber of the Catskill aqueduct. I am not advocating that kind of foundation where one can get a foundation that is more rigid, but, nevertheless, it did very well. Those pumps are each of twenty-two million capacity, and they have operated satisfactorily during the time we have used them, and we do not anticipate changing the type of foundation.

On the question of piping; flange pipe is very good, but personally I would always like to see, at some point in an installation, a joint that is not fixed or rigid so there can be a movement that can be taken up which will permit you to put your piping together without stressing the flanges and which will permit you, when you take it apart, to put it together again with a little play to allow for the

[1] Presented before the St. Louis Convention, June 2, 1930.

[2] Chief Engineer, Department of Water Supply, Gas and Electricity, New York, N. Y.

inaccuracies of the make up of different pieces and to give you the opportunity to get your gaskets in and then draw up without putting the flanges under high stress. Probably a number of you have had the experience where flanges have given away and they have given away not because of their weakness, but because, in making up the joints, the flanges have been forced in order to make up for this slight space which was necessary to get the gaskets in. In general, you can design so you will have one or more joints that can take up the difference in lengths and directions of the piping, so when you get through you have a line that is free from stresses developed in putting the pipe together.

In regard to the check valve, we had some very serious trouble. We finally gave up shutting down the pump before we shut the gate valve. Any check valve is likely to stick occasionally and when it does it causes you a lot of trouble. We made some changes in the check valve design and then they operated quite satisfactorily, but I think our practice still is to shut down the gate valve first and then shut down the pumping. That is certain to get rid of the water hammer.

Those points may be interesting to you because they represent what has been done with a hurry-up job which has worked out quite satisfactorily during the past three years, with pumping at times of sixty million gallons or over a day.

L. S. VANCE:[3] Mr. Brush was speaking of water hammer developed in connection with the sudden closing of flap check valves. We have had considerable experience with that same thing in Louisville. The check valve installation is in the discharge piping from a 60 m.g.d. electric centrifugal pump, which raises the water some 155 feet to the sedimentation basins. This pump was operated alone and only for fifteen to eighteen hours per day. In stopping the pump it was the practice merely to open the switches. The result was about as follows. When the output of the pump stopped, the automatic valve on the pump discharge closed. However, the inertia of the water in the rising mains was enough to continue the flow for an appreciable time interval so that a gauge in the discharge pipe would show a pressure apparently below zero. Then as this flow reversed, due to gravity, the pressure would build up to something over 120 pounds per square inch in front of the flap check valves. The water in these rising mains would oscillate with a frequency of about fifteen seconds with

[3] Louisville Water Company, Louisville, Ky.

gradually decreasing limits of pressure until the water settled down and the pressure reverted to the static head. We had considerable trouble maintaining solid walled cast iron pipe, until we stopped the pump only after gradually closing the discharge valve manually thereby slowly decreasing the velocity through the rising mains and eliminating the flow due to inertia after the pump was stopped. In this way the pressure kick-back was eliminated, it previously having been severe enough to break 30- and 36-inch mains two or three times.

D. D. GROSS:[4] In Denver we have had experience with different methods of priming pumps. In the case of suction lift on centrifugal pumps, we found the most satisfactory means available was the use of steam ejectors. In the case of electrical driven pumps, we have had some difficulty in obtaining power, that is, making satisfactory arrangements for power with the power company because of the high load placed on the power line when a centrifugal pump driven by a synchronous motor was first put into service. We found by closing the gate valve on the discharge that we could start the pump with the use of less power. We also found that we could obtain electrical control devices for starting the motor at less than full speed. By these methods we are enabled to start the pump without putting the high load on the power line that was objected to by the power company.

In this connection, I might add that, in the case of large pumps, we use a motor operated valve on the pump discharge, making it very easy to operate the valve. As stated, we have valve closed when starting the pump, open it after the pump is in operation and close this valve before shutting off the pump. This method eliminates water hammer in the pipe due to starting and stopping the pump.

LUTHER GARRY: I should like to know from the experiences of others what is the minimum size pump discharge that should be used with a single flapper, for instance, or when should the multiple form of check valve be used for a pump that is operating, for example, under about 65 or 70 pounds pressure with a 24-inch discharge. What size openings would seem best adapted in order to produce a more satisfactory operation?

[4] Chief Engineer, Board of Water Commissioners, Denver, Colo.

JAMES E. GIBSON:[5] I do not know that I can answer the question, but certainly on a 24-inch discharge main I would use a form of pump deck check valve, that is, a multiplicity of small valves running not over 4 inches in diameter each. When to use a double beat, or flapper as you termed it, I certainly would begin to use a double beat check somewhere on an 8- or 10- inches diameter main and larger. My experience is that you will always have this ram when you shut off a pump without first closing a discharge valve, even when the multiple valve check is used. I know of no way to avoid it. Air chambers on discharge lines will relieve it, but they do not stop it. The air chamber is a relief because you get the kick against the air cushion and slow the velocity of the water.

Regarding priming pumps, where you have a pump set above the suction water level; in isolated cases we have used a small reciprocating displacement pump driven by gasoline engine, connecting the suction of this pump to the top of the highest point of casing of the main pump, and with a tight check valve in the discharge of main pump you can fill the suction line and main pump before starting up. It is necessary in these cases to have a tight suction line, with a minimum leakage. I have in mind now a case where the lift was 6 feet maximum, 8 feet to the top of the pump casing, 20 inches suction, that when the piping was tight, no leaks at all, and the small engine and pump in good shape, we could start up in about five or six minutes after starting the small pump. If we let our shaft gland packing get in poor condition it would take a half hour sometimes. So you have to have tight joints if you have that kind of an installation.

H. KELLNER:[6] In Windsor we have a plant which has 25 million Imperial gallons capacity by Hydro Electrical power, also 25 m.g.d. by steam power. We find that during electrical interruptions we are rather seriously troubled by surge conditions, especially at the discharge check valve of our largest (12 million gallon) capacity pump. We consider these surge conditions may have serious results unless they are rectified.

We of course get no warning of interruptions and when these happen, the check valves in the discharge of the centrifugal pumps close immediately and produce these surge shocks, the pressure at these

[5] Manager and Engineer, Water Department, Charleston, S. C.
[6] Chief Engineer, Water Works, Windsor, Ontario, Canada.

periods rising to 195 pounds is accompanied by a terrific noise at the check valve.

We have been wondering just what methods we might employ to rectify these surge conditions.

We did not have very many interruptions in the last year and a half, but they totalled three hours and forty-seven minutes. The three hours represents a break in the transmission lines, and the forty-seven minutes represent only spasmodic interruptions.

I would be very pleased to hear if any other members have had a similar experience and if they could give us any information that would help to correct these conditions.

ANTHONY KEILS:[7] In answering the gentleman's question, we changed from a well system to a lake supply. We have a difference in elevation from the pumping station to the tank of about 215 feet. We have that surging back that he referred to and in order to eliminate it we installed an 8-inch line from the 24-inch discharge, back into the building with an automatic relief valve, in case the electric power drops off. This valve takes care of the surging and lets the water into a sump. That valve is set at 90 pounds or a fraction over. This is carried ordinarily to take care of the pressure in the city between that and the elevation of the tank. We have found by observation that this pressure does not exceed 100 pounds.

H. KELLNER:[6] That about answers the questions. I met a man last year in Toronto who had a similar experience in that he had a relief valve about one third the capacity of the pipe. I had already recommended a relief valve, but I was proposing that a valve be put in on our line about the same size as yours, 24 inches, as suggested. To make sure of a 24-inch relief, I suggested that we put about ten pounds over our maximum operating pressure. If any of the other members have any further information on the necessary size of a relief valve for such a condition I would be very much interested.

MR. SCHAUM: I just wanted to say that I am not selling any relief or check valves, but I wanted to ask if he had ever investigated the merits or demerits of an automatic valve for the discharge of that line and, if so, with what result. I believe that is one way of remedying the trouble.

[7] Superintendent, Water Works, Mt. Clemens, Mich.

H. KELLNER: I might say that the discharge check valve was installed about two years ago. These were specified and our engineer did not expect to have this condition. Had we had any of that we might have put a valve in something similar to the automatic valve which you see on the floor, but the valve is already installed and it is not desirable to scrap it if we can get around it in any other economical manner. If we were putting in another pump like that we would.

CLEARANCE BETWEEN WATER MAINS AND SUBSURFACE STRUCTURES

WM. W. BRUSH:[2] I am to talk to you for a few minutes on the question of keeping loads off of mains for which they are not designed. Those of us who have to do with the distribution systems of the various communities have a break every once in a while, sometimes much more frequently than is comfortable. Then we have to make a shutdown and we have usually some damages to street pavement, possibly also to property of the citizens that may be stored in the basements of the buildings. In general it is not a satisfactory situation. Our observation of the causes of breakage has indicated that of the some three hundred breaks we have a year in New York City the greater number of them are caused by the external conditions. If you take the cast iron pipe, which is the usual form of pipe in our distribution system, it has the relatively large factor of safety of from five to six. Now, why should it break? It is very seldom, based upon what I have seen of breaks in water mains, that you can attribute it to defective material, but usually you can find evidence that the pipe has been subjected to a load that is greater than the metal will stand. In the case of the smaller pipes, say up to 8 inches in diameter, you will usually find that the break comes at right angles to the axis of the pipe due to external loading, because the pipe as a beam is of less strength than it is in the bell where the deflection is taken up to a great extent by the jointing material. When you get to 8 inches we find that the percentage of breaks across the pipe are about even as compared to breaks in the bell. Above 8 inches the breaks are almost entirely in the bells of the pipe. With the larger pipe we have breaks, and with some of the smaller pipes, which are undoubtedly due very largely to loads that are brought upon the pipe by other structures which cross over them.

In my earlier years in the Water Department, I was told by the older men that if you have an earth cushion between two pipes or two structures that was all that was necessary to relieve the load that would otherwise be brought to bear upon your water main. In my opinion this provision of earth between the pipes means prac-

tically nothing from the viewpoint of materially reducing the load that is transmited to the pipe from, and as a result of, a structure crossing over the pipe at any distance of, let us say, three, four, five, six or a dozen inches from the water mains, especially of the mains that are 12 inches or a little larger in diameter. We do not hesitate to rest a building upon earth as the foundation. That earth is transmitting that load to the earth beneath it. Why should we have any material difference if we have a water main, with another main crossing it, or we have a subway duct or any other subsurface structure crossing it, what is the difference if we have earth packed in between the two structures? Probably the earth will pack in as a result of the action of gravity and the softening at times of the earth by the water which finds its way down to the earth from rainfall or other sources. Therefore, in New York we have adopted the plan that when any structure is over the water main, unless it is a very small structure as a 4-inch subway pipe or similar structure, we call upon the owner to support his structure on each side of the water main by carrying down the foundation, usually a foundation of brick or other masonry, to a level below the middle of the pipe. And we try to see to it that if two water mains cross one another, the water main that is above the other is supported in a similar manner. So that we try to preserve as near as we can the full factor of safety of the water pipe for the purpose of carrying some unusual and unforseen load that may come upon it rather than placing deliberately upon it a load the amount of which we do not know.

Such a plan adds to the cost of construction but also adds to the safety of the main. It is not sound construction practice to put unnecessary, uncertain loads on a structure and then say that we have done a good job. It is not a good job and the communities that we serve will be much better served if we try to see to it that our water mains are so constructed and thereafter so protected that they will have brought upon them only the water pressure from the interior of the pipe and such unavoidable stress that may come by a settlement which cannot reasonably be foreseen and avoided. I personally would be very much interested in hearing from other men who have had experience, as practically all of you have had, as to what your practice is, and what your views are on this subject, but we believe in New York that literally hundreds of thousands of dollars that have been spent in recent years by public service corporations and ourselves have been well spent in reducing the external

load on the water pipe, and we certainly believe that a cushion of earth between two pipes, or between a pipe and another structure crossing it, is in no way a safeguard against transmitting the load of the upper to the lower structure.

WILLIAM MOLIS:[5] Did you have one cast iron main truss break over the concrete supports?

WM. W. BRUSH:[2] We have only had, to my knowledge, one break that has come where we have supported pipes on concrete bases. In our very extensive system of rapid transit subways that are being constructed in New York City, with the engineers of the subway department, we have adopted a system of concrete supports for our water mains where the distance from the water main to the top of the subway structure is more than 3 feet. Where the water main crosses at right angles to a subway structure the concrete supports are carried outside of the triangle of disturbance of the earth due to the excavating for the subway. Within that area you are liable to have the movement. A concrete foundation below the line of disturbance is carried from the subgrade up through the side of the bank and the water main is supported until it enters earth, which is probably not affected in any way by the subway construction. As far as I can determine the one break that we had was occasioned by the field engineers, who are not in sympathy at all with this matter, putting the supports about twice as far apart as the designers in their own department called for. We find that it is necessary to place the support under the water main for half of the length of the main to give a safe load or a safe support for the water main. In other words, if we take a twelve foot pipe, then we have two 3-foot supports under that pipe so that 6 feet out of the twelve are supported. That support is carried up around the sides of the pipe about half way between the horizontal and the central section of the pipe. We find, or at least our designers tell us, that approximately ten feet of earth covering is about the maximum that you can say is safe on the ordinary cast iron pipe.

It is also a problem, as Mr. Molis has indicated, in carrying the pipe on fixed supports, to do so in the earth in such a manner that you do not get the excessive stress on the pipe at a point that is least rigidly supported. Years ago, we used to be very much troubled about that,

[5] Superintendent, Water Works, Muscatine, Ia.

but I had a good many experiences where I had trouble when I did not support the mains. Lately we adopted the present plan, which is certainly perfectly sound from the viewpoint of carrying the supports until the pipe is in an area which is not likely to be disturbed or where you have a perfectly sound earth foundation. We have the unusual situation of many excavations for subways, sewers, steam mains, electric ducts and other subsurface structures that are carried below the level of the pipe. Perhaps others do not have a great amount of that work. New York has to go below the ground mainly in its development and everywhere we have those subsurface disturbances, but we certainly have no evidence that a soundly designed support for your water mains will not result in a decided increase in the safety of the structure and you have then a structure supported on the basis of sound engineering principles which will stand up under the probable future condition that will affect it.

A. O. DOANE:[9] I would like to ask Mr. Brush in what connection the public service put in a duct or something under your pipe. By installing a conduit underneath the pipe sometimes a serious break will result. Sometimes they did not touch the pipe, but the pipe had settled down and made the break over the concrete. In fact, the records show in our territory that eight-tenths of the breaks are caused by unequal settlement, the pipe being supported unequally.

WM. W. BRUSH:[2] If the structure is of sufficient size in its horizontal or vertical dimensions so as to make its span an unsafe one for the water main after you consider the area of earth that would probably be disturbed as a result of the depth of the excavation for the duct bank, then we require the company that is interested to build supports and to carry beams under the pipe or other form of constructions that will bring the load on the water main within the limits of what our designers consider to be safe. In other words, Mr. Doane, we turn to our design division in structures of any size for a safe design. We tell the owner of the structure that that is what you have to build. At first we had a good deal of trouble with the foreman who thought it was a rather smart thing for the company not to support the water main properly. It is to their interest to have the water main properly supported and the foremen have been instructed to work with us. We have now very little difficulty in

[9] Water Division, Metropolitan District Commission, Boston, Mass.

getting any kind of structure which we decide is necessary. Of course, our designers see to it that the structure is never unnecessarily expensive. It never pays to spend a dollar of your own money or the company's where you do not get a dollar's worth in return, but it never pays to avoid spending a dollar and taking a chance.

A. O. DOANE:[7] The city has also had considerable difficulty with what you mention, that is, the mains going over the subway and then in the disturbed ground, but I do not think they took care of it in as good a manner as you say.

WM. W. BRUSH:[2] Neither did we, Mr. Doane, until we had some very sad experiences.

JAMES E. GIBSON:[5] I am not going to discuss this, but I am going to ask a question, the result of some experiences we have had within the last eighteen months or two years. We have, very much like Mr. Brush, one entrance into Charleston as he has Broadway into New York. We call this entrance King Street or Meeting Street Road. There are in reality two roads now, with a railroad track between. The traffic is north on the right hand side and south on the left hand side going out of the city. We laid a duplicate 24-inch main line in these two streets about a hundred feet apart and cross connected them with a 12-inch pipe, and in so doing we had two 12-inch valves to come in direct line north and south with the north bound traffic. About eighteen months ago the bonnet of one of these valves cracked off. These valves were not in valve pits but had the ordinary standard valve box with a loose connection extension for adjustment to accommodate the depth. Examination of the broken bonnet showed that in casting the core had shifted so that one side was thinner than the other. We submitted it, not as a complaint but as a matter of information, to the valve manufacturer and he said, "All right, we will assume that it is all our fault and replace the bonnet." That was the north valve. We repaired that. In about six months we had the south valve crack the same way. The crack developed on the north side or in the opposite direction from traffic. We ordered a reinforced bonnet and I do not think that this bonnet had gotten warm in its new position until the north valve again broke. We began to sit up and scratch our heads. In the meantime a manhole cover on the west side of a main sewer cocked up on one side

about 4 inches and the ring of the manhole cover was broken. The highway department—this happened to be at the junction between the city and state highway,—notified us that our manhole was out of level and we would have to do something. I passed the buck by saying we did not have anything to do with the manhole, since it belonged to the sewer department of the city, and they would have to take it up with that department. About this time the fourth bonnet cracked. I said, "Well, we will take the bull by the horns now," and put these valves in large manholes. I then got in touch with the highway department of the state to repair the paving where we had cut it up and in talking to their engineers I said, "We are up in the air as to what is breaking these valves." He laughed and said, "Well, we will have to charge you for replacing the pavement, Mr. Gibson, but I think we are to blame." I said, "What do you mean?" He said, "Well, I mean that the concrete subbase of that road is expanding longitudinally and it is just simply pushing your valve boxes over against the valve and snapping the bonnets off at the weakest point." I said, "How do you know that?" He said, "You remember we had to cut out the end of that road there and replace a portion of it about three or four weeks ago?" I said, "Yes, I noticed you working there but I did not know what you were doing." He said, "Well, that is what happened. He further stated that in the upper portion of the state in 18 miles of concrete road they had in the last two years cut out an estimated 600 feet of concrete due to expansion of the concrete subbase." That seemed almost impossible to me, but he gave me those figures as actual fact. It was simply expansion that had crushed the sewer manhole frame. I would like to know if any one else has had such an experience.

CHAIRMAN SHEEHAN: I will state, Mr. Gibson, that our city is putting in a good many concrete streets, but we have not had anything of that kind yet.

JAMES E. GIBSON:[5] The highway department of South Carolina blames this condition on the cement used in the road. They say certain grades of cement, I think if you will review some of the discussion you will find that certain chemicals are in cement that the boiling test will not disclose. It causes trouble and the expansion will continue for as long a period as three years if a certain element in excess of a certain percentage is present. A few companies in the

country have that difficulty and you want to avoid that kind of cement in concrete work, for road work in particular. I am told that the 18 mile roadway expansion has been enough to push up the foundation of buildings. We have had quite a little bit of trouble with that quality of cement.

J. WALTER ACKERMAN: I would like to ask Mr. Gibson whether this cement is what we now know as high early strength?

MR. GIBSON: No, it is not.

THOMAS J. SKINKER:[10] I would like to ask Mr. Gibson what cover he has on his pipes.

MR. GIBSON:[5] We have adopted as a standard a minimum of 30 inches, actual covering, in the larger pipes, 24-inch. Where they are not likely to be paved, in private right-of-ways, we do allow as little as 24 inches of covering, but where the system was first put in in 1880, we very often find that we have less than a foot of covering below the subgrade of the paving. I agree absolutely with Mr. Brush that about all the earth cushion does is to flatten out the vibration and make the peaks a little bit lower.

MR. SKINKER:[10] The thing I could not understand is how the expansion of your concrete with the buffalo type box, I presume that your valve box is the buffalo box, could break the bonnet upon your valve.

MR. GIBSON:[5] It was not exactly the buffalo type of valve bonnet, but it was the same general design. At this particular place the covering on the 12-inch main was about 30 inches. This box sits down over the bonnet of the valve and the other part sits down close to it. The concrete moving southward shoved the box over against the north side of the stuffing box, and I presume, acted as a lever on the bonnet and it snapped at the weakest point. The first valve broke very near the flanges, the others broke up near the neck of the bonnet where it joins the stuffing box. This is the only plausible explanation that we have been able to assign for this breakage. We built the manholes large enough for a man to get in and replace the

[10] Water Department, St. Louis, Mo.

entire bonnet. They have been in now about three months and, of course, we had no more trouble. In this case the highway department replaced the concrete by putting a ring about our manhole rings—a concrete that they call "black base" made up of asphaltum and crushed stone. They did that on their own responsibility and our arrangement with the state, as well as with the city, is that they make all the street or highway repairs and bill us for the cost. We have found this to be the most satisfactory because then they assumed the responsibility as to the quality of material, and we pay the bill. We backfill the trench, but they reserve the right to replace it if it is not done satisfactorily to them.

MR. SKINKER:[10] Mr. Gibson, did the concrete expand only in one direction?

MR. GIBSON: It expanded both ways.

MR. CRAIG: Why did it all come this way to push your valve?

MR. GIBSON:[5] The highway ended just south of this location, about twenty feet. The adjoining highway was a different type of construction and the expansion of the state highway extended back for probably a half mile or more because it was a straight road. It could not expand any other way, that is, it took the path of least resistance which was south. It also expanded horizontally because the highway department had to cut the curb on the west edge or side and replace with new curb. The highway department think that the expansion period has passed for this piece of road. It has been laid a little over two years. This road was laid in the winter time, that is, in the fall and winter of year before last. When this bucking up stunt first occurred the next summer, the first summer, they attributed it to the heat, and did not think much about it; but the following winter when the weather got cooler these buckles increased. They actually took out more buckles in the second winter than the first summer after the road was laid.

MR. SKINKER:[10] I would like to ask Mr. Gibson if he was able to determine how much expansion they were able to measure.

MR. GIBSON:[5] We did not, the highway department did. They say it is about three percent normally. In the upper part of the state they had an 18-foot road that expanded six inches in width. That is the best they could make out of it. They did not anticipate anything like this, and they have found that this condition will occur only with certain kinds of cement. The analysis of the cement in this concrete made from samples of the concrete taken from the subbase shows that it was of this class of cement. It was an American cement and needless to say they are not using it in the South Carolina Highways any more. The irony of it, however, though, is that when we were trying to get a cement for lining cast iron pipes two or three years ago, we tried to get a cement mortar that would expand upon setting and we could not find a cement manufacturer in the country that would offer any such goods of cement.

INSPECTION OF FIRE HYDRANTS AND DIVISION OF RESPONSIBILITY BETWEEN FIRE AND WATER DEPARTMENTS

C. W. WINKLE:[11] In the consideration of this topic, our attention should first be centered upon that portion which seems to be of major importance, namely, the "Division of Responsibility between Fire and Water Departments."

There is placed upon these two Departments exacting responsibilities in the matter of adequate fire protection service. It is of vital importance that there be a proper understanding of the several responsibilities and a coöperative effort which will secure that adequate fire service so essential to the well being of the City.

Engineering authorities have wisely decreed that the responsibility of the water department is the maintenance of good fire protection equipment and the furnishing of an adequate supply of water under reasonable pressure, and that the responsibility of the fire department is the adding of a sufficient pressure and the effective and competent utilization of that water service so that there will be the best possible fire protection.

Ideal fire protection service can only be realized through wholehearted coöperation between the fire and water departments.

The United States Joint Fire Prevention Committee, of which the American Water Works Association is an active member, has well covered this matter in the first of its twelve aims for accomplishment, that aim reading as follows:

"The establishment of such close coöperation between the fire and water Departments of our Cities as will insure the most effective and competent utilization of the water supply in fire fighting."

Wholehearted coöperation between these departments would cause the fire department to join with the water department in insisting that a fire hydrant is a fire protection device and not an attachment for the use of street and sewer flushing crews, street contractors,

[11] Superintendent, Maintenance and Transportation, Indianapolis Water Company, Indianapolis, Ind.

building contractors, or any one else who desires to obtain a supply of water.

The American Water Works Association has repeatedly raised its voice in disapproval of the indiscriminate use of public fire hydrants, and on numerous occasions has recommended the limiting of the use of public fire hydrants to public fire protection service only.

The condition of the public fire hydrants depends to a large degree upon the use to which the hydrants have been placed, and a consideration of the first part of this topic, namely, the inspection of fire hydrants, must take into account the use to which the hydrants are placed. What may be adequate inspection in one city, where the use of fire hydrants is limited, would in another city be entirely inadequate because of the indiscriminate use of those fire fighting devices.

The National Board of Fire Underwriters recommends that "hydrants shall be inspected in the spring and fall of each year, after use at fires during freezing weather, and daily in high value districts during protracted periods of severe cold." Such inspections should insure the good working condition of the fire hydrants, provided their use is limited to the fire or water department employes.

In an effort to eliminate all unnecessary use of public fire hydrants in Indianapolis, the Indianapolis Water Company set aside 20 smaller type fire hydrants in the high value district, and these were equipped with special $1\frac{7}{8}$-inch inside diameter connections for use by the street flushing crews, or other city employes charged with the use of city water. In addition, $1\frac{7}{8}$-inch inside diameter connections were placed on one nozzle of approximately 175 fire hydrants in the city, and the street sweeping and flushing crews make connection with these $1\frac{7}{8}$-inch inside diameter outlets. All of the city street flushing or street sweeping equipment is provided with special $1\frac{7}{8}$-inch connections, thereby making it impossible for them to connect to the regular $2\frac{1}{2}$-inch fire hydrant outlet. This plan, while placing a burden of expense on our company, has been of immeasurable value in safeguarding the good working condition of the public fire hydrants.

In the fall of each year, our company makes a careful inspection of all hydrants, both public and private, and all necessary repairs are made in connection with that inspection. Hydrants of certain types which are liable to frost damage at the opening nut are sealed with a composition of lubricating oil and graphite, and so well has this protected this type of hydrant that no trouble has been reported from frozen hydrants for several years. We are now experimenting

with Alemite cup grease for sealing around the opening nut collar and expect to use it in the future.

The fall test is made as late as possible and covers three specific tests:

1. A test to determine whether the waste valve at the bottom of the hydrant is free from obstruction.
2. A test to see that the stuffing box does not leak.
3. A test to see that the hydrant opens and closes properly and that all nozzles and nozzle caps are in good condition.

At the time of the spring flushing of the water mains, we inspect and operate approximately 75 percent of all of the public fire hydrants, and repairs are made to any hydrants which are then found to be defective.

As an added effort to insure the good working condition of the fire hydrants, and the furnishing of the best possible fire protection service, the Indianapolis Water Company has for years employed a carefully trained man, who attends each alarm fire and inspects the fire hydrants and hose line during and after the fire. During the course of the fire, each hydrant is inspected to be sure that it is fully open, and after the fire each hydrant used is again inspected and operated to see that it has been left in good working condition. Report is made of any defect, however minor that defect may be, and repairs are made at once.

With the fall inspection, which covers all public and private fire hydrants; the spring inspection, which covers approximately 75 percent of all public hydrants, and the inspection of all hydrants used at fires, we estimate that every public and private fire hydrant in Indianapolis is inspected at least twice each year. We do not make daily inspection of the fire hydrants in the high value districts during protracted periods of severe cold, it being our experience that the least bothering of the hydrant the better.

Our experience in the care and maintenance of fire hydrants causes us to place special importance upon the proper setting of fire hydrants. It is of vital importance that the hydrant have a proper drip bed, with an adequate supply of coarse gravel, broken stone, or brick bats, around the base of the hydrant to give free flow for waste of water from the hydrant barrel.

Another item of importance is the location of the fire hydrant at a sufficient distance from any tree so that tree roots cannot find their way into the barrel of the hydrant and impede the flow of water.

If we were called upon to list the important steps leading to the good working condition of fire hydrants, we might well list them as follows:

Install the hydrants with proper drip beds, etc., and locate them sufficiently far from the curb or corner so that they will cease to act as automobile bumping posts.

Inspect the hydrants twice each year, and especially after each fire, making all necessary repairs, however minor those repairs may be.

Limit the use of fire hydrants to the Fire Department, or employes or authorized agents of the Water Department.

Of these three steps we might well say that the last is probably of ranking importance.

This brief paper has been based on our experience at Indianapolis in our attempt to keep the fire hydrants in good working condition. The extent to which this result has been achieved is shown from the recent report of the National Board of Fire Underwriters, one paragraph of which reads as follows:

"Of the 300 hydrants operated by National Board Engineers, all were in operative condition, with only a few in need of minor repairs, and the general condition was good."

WILLIAM LUSCOMBE:[12] I would be glad to have somebody suggest where a fire hydrant could be placed so as not to be used as a bumping post for automobiles.

MR. WINKLE:[11] While we have, of course, thousands of fire hydrants that are located too close, in constructing our new pipe lines it would be a very good idea to locate hydrants back at least about 20 or 25 feet from the intersecting curb line. I think you will find in doing that that you will overcome a great deal of the trouble from the reckless automobile driving or the driver that gets a little too much mixed up in his gasoline.

MR. HANKLE: I would like to ask Mr. Winkle what provision he makes for keeping building contractors from using hydrants.

MR. WINKLE:[11] We furnish water to contractors from fire hydrants, but it is under the supervision of one of our employees. We put a 2-inch valve connection on one of the nozzels of the hydrant, open the

[12] Vice-President, Gary Heat, Light and Water Company, Gary, Ind.

hydrant up full and then the contractor operates the hydrant from the 2-inch valve which is reduced down to about, in most cases, a 2-inch opening and our man looks after this contracting work and closes and opens them at nights and mornings. The fire department is notified where these hydrants are equipped with the contractor's connection. If it is on a street that has been blocked off for several squares we do not close it up each night and open each morning until the contractor gets through. The fire department is prepared for the contracting should they have to get into the street. They understand that when they get to this hydrant with the 2-inch valve connection on the 2½-inch nozzle they first have to close the hydrant before they can make connections thereto. We found that we have had very good results in this way of handling contractors. We do not allow any one to use our hydrants promiscuously. That has to be done either under the supervision of the city fire department or some of the city crews or under the supervision of our own employees.

A MEMBER: Is there a charge made to the contractors for this service?

MR. WINKLE:[11] No, we have a flat rate charge for the concrete work, at so much per square yard.

A MEMBER: How many still use the chains on hydrant caps?

PHIL CARLIN:[13] We have 1515 hydrants in Sioux City and we use the chains on all the older hydrants. On the new hydrants we are not using them. We find that that is much better. I was going to ask you about placing these hydrants about 25 feet from the curb. They would not let us do that in Sioux City. The firemen object to it. They say this is too far back from the curb. We do not go farther than 15 to 18 feet.

MR. WINKLE:[11] You probably misunderstood me a little. I mean to set the hydrant facing from about 25 feet back from the street. We place our hydrant not over 5½ feet back of the curb line. That is where our sidewalks have not yet been put down. We set the hydrant back about 5 feet so if they install a walk next to the curb the hydrant will be back next to the walk but will still be along on the outside of the street side.

[13] Superintendent, Water Works, Sioux City, Ia.

W. S. PATTON:[14] In my town the fire department does not want chains and I have not lost a cap so far. It certainly does help the fireman to get at the water quickly. I believe that chains are useless.

MR. CONNOLLY: I am from St. Louis where we require a guarantee deposit from the contractors, to protect us from damage on the hydrant, which, of course, is not adequate in many cases. We also charge $10.00 per month for a permit in addition to the water charge under schedule rate. That has lessened the demand for the use of hydrants. The small jobs now are not so apt to come in and want a hydrant turned on. They will negotiate with the neighbors for a hose, and I do not think any method is entirely satisfactory, but we are probably getting along as well as could be expected in our climate.

MR. LUSCOMBE:[12] We have quite a number of fire hydrants broken by trucks. They are broken beyond repair. I believe in 75 percent of the cases we have not been able to find out who the guilty party is. Of course, it is usually the skip-and-run autoists. I would be glad to have anybody here enlighten me on how one can so conduct and handle such matters so that the water department is reimbursed for the damage done by the guilty party.

CHAIRMAN SHEEHAN: I expect you have a proposition to which every water department and fire department in the country would like to have some answer.

MR. LUSCOMBE:[12] You have talked about setting a hydrant back about 16 feet. Some fellow tore a hydrant down and knocked it 20 feet. We never found out who he was. We have been looking for him ever since.

[14] Manager, Water Works, Ashland, Ky.

FROST PROTECTION FOR EXPOSED WATER MAINS

R. L. DOBBIN:[15] The Manual of Water Works Practice is silent on the matter of frost protection for exposed water mains, which subject is of great importance in the northern parts of North America.

A search through the JOURNAL of the Association from 1908 reveals no papers or discussion on the subject until 1928 when Mr. George Routledge, Superintendent of Distribution of the Toronto Water Works Department, read a paper before the Canadian Section on "Constructing Water Mains on Bridges," which described various methods of protecting such mains. This paper was published in the August, 1928, number of the JOURNAL.

One method described by Mr. Routledge consisted of constructing a wooden box around the main, and filling the space betwen the main and the box with dry saw-dust to a minimum thickness of 3 inches.

A second method was to cover the main with layers of insulating felt to a thickness of 2 inches, and then cover the whole with a jacket of metal or heavy ashphalt roofing secured with galvanzied iron or copper wire.

Other methods consist of using a very thick layer of gypsum around the main.

All of these methods are very satisfatory, but our experience has been that there must be circulation of water in the main to keep it from freezing. The amount of circulation may be very little. Mr. Routledge in one of his experiments found that as little a flow as 0.16 gallon per minute would keep a 6-inch un-insulated main from freezing when the temperature was 4 degrees above zero.

A great deal depends on what the temperature of the water is in the main where it is not exposed. If it is normally close to freezing a greater circulation of water is required in the exposed pipe.

It is our practice to place a blow-off close to the end of an exposed main so that it can be de-watered in a short time if required, as we have found that no amount of insulation will prevent a main from freezing if there is no water circulating in it.

[15] General Manager, Feterborough Utilities Commission, Peterborough, Ontario, Can.

We can always tell when an exposed main is very near freezing as we will have complaints of dirty water from the consumers nearby.

In a water main, when frost attacks it, the ice forms in the pipe first on the inside of the metal of the pipe. As the action progresses the ice accumulates on the perimeter and gradually closes in to the center. While this is going on all the tubercles and slime which ordinarily clings to the pipe are removed and forced to the center.

If the pipe is allowed to freeze completely, all the dirt will be found at the center of the block of ice. This accounts for the prevalence of dirty water just before the main finally freezes solid.

An interesting development in regard to exposed water mains is taking place in connection with the installation of a water works system for the coming Port and City of Churchill, northern terminus of the Hudson Bay Railway.

Ordinary methods of laying water mains below the frost line are not suitable, as borings as deep as 117 feet have reached solid rock before coming to the end of the frozen soil which never thaws out.

To keep the water mains in service during the long winters will be a great problem, and it is expected that the solution has been found as follows. The mains will be laid on top of the ground and covered all round with 4 feet of dry moss. The pipes will be supported on wooden posts driven into the clay, and when covered with the moss, will be sheeted with sheet iron and thatched straw to prevent the moss from getting wet, thus turning it into a good conductor of cold. It will be interesting to see how this scheme will work out.

MR. BRUSH:[2] In connection with the question of frost protection of mains and services, I would refer those who are interested to the Board of Transportation of the City of New York, which has made a most extensive set of experiments on this subject.[16] That board carried on its experiments to determine what could be done in the way of preventing the freezing of services where the service was carried through subway ventilators and where there was therefore no protection from low temperature air. As Mr. Dobbin has said, if you keep up a flow so that the temperature of the water is held to any fraction of a degree above 32 degrees, no ice will form. Most of us do not know just what that flow is in any given case. The result is we guess at it; in the winter time we develop a flow hoping that we are

[16] A summary of this work was published in THE JOURNAL, November, 1927, page 564. *Editor.*

running the water at not too high a rate and thereby unnecessarily wasting water and also hoping that we are running at high enough a rate of flow so that the mains will not freeze. In a good many instances it very probably would pay to place a reasonable amount of insulation around the pipe so that the amount of flow could be reduced. As far as I know, the only way you can determine the flow that is required is to test the temperature of the water as it comes out of your blowoff and determine what rate is necessary to keep it above 32 degrees. One tenth of a degree above 32 is all that is necessary to prevent ice forming in your pipe. Our general practice is to lay the mains on unexposed areas because there we can have circulation or rate of flow sufficient to prevent freezing without waste of water, but there are numerous pipes where in the winter we have to start a flow through a blowoff that is a drip or sometimes quite a substantial flow where pipes are laid in the salt water and the temperature may get down in the surrounding water to 26 degrees, then we have to see that the water flowing through the pipe does not get to 32 degrees or below.

WATER MAINS ON BRIDGES AND AIR RELIEF VALVES IN COLD CLIMATES

G. G. ROUTLEDGE:[17] The size of the main should be ample for present and estimated future requirements.

As the pipes are likely to be subject to vibration, and stresses considerably greater than they would be under ground, they should be of wrought iron or steel with special attention given to their protection from rust and tuberculation.

The openings in the bridge abutments for the pipes should be large enought to permit the pipes to be passed through them and leave sufficient space for insulation.

Scaffolding usually secured to bridge members will, in most cases, be necessary for the construction of the pipe line, and where possible should be permanent for pipe inspection and repairs.

In some cases the most convenient method of getting the pipes into position is to pass them through the openings in the abutments and then move them on rollers on the scaffold. In others it will be more convenient to hoist them unto the scaffold from some point below the bridge.

Bridges, on which pipes have to be placed, vary so much in design that the best method of supporting the pipes also varies very considerably.

In some cases, brackets supporting the sidewalk provide convenient supports for the pipes; in others, the pipes can be suspended with iron rods from the floor beams or attached to other bridge members.

It is advisable to have two supports to each pipe, so that in the event of a failure at a joint, the pipe itself will be securely held in position.

PIPE JOINTS

Until a few years ago only two kinds of joints for pipes on bridges have been used; the ordinary screw coupling or flanged and bolted.

The screw coupling joints have been found a little more difficult to make water-tight, but when once tight remain so. They also have an

[17] Superintendent, Water Distribution Section, Toronto, Ont.

advantage over flanged joints as they offer no difficulty to the installation of insulating materials.

Flanged joints permit of a pipe being taken out of the line more easily, but in these days a repair would usually be made by welding rather than removing the pipe.

As both of these joints are practically rigid, it is advisable to install special joints to take care of expansion and contraction in the pipe. The ordinary stuffing box type of expansion joint has been satisfactory.

The range of change in temperature of Lake Ontario water is about 40° which would mean a variation in length of a 20 feet length of pipe of $\frac{1}{16}$-inch.

The material of which the bridge is constructed will generally be subject to a range of temperature two or three times that of the pipe, and will result in movement at the points where pipe is attached, and possibly disturb the insulation at these points.

This has been avoided during the last few years by using "Victaulic" couplings thus making each joint an expansion joint. They permit a movement, without leakage, considerably greater than that resulting from changes in temperature.

AIR VALVES

In most cases the construction of a pipe line on a bridge results in a high spot where air may accumulate.

Automatic air valves and ordinary 1-inch connections with gate valves have been used for the removal of air at the high points, and these have given more trouble, especially the former, than any joint or other fitting on the bridge.

The high spot is usually at the center of the span, and in a position difficult of access for inspection and repairs. In some cases a manhole in the floor of the bridge can be constructed to provide access, but in most cases it will have to be reached from below with ladders or scaffolding.

In order to find the velocity necessary to remove air from the high point in an 8-inch pipe, an experiment was made with a $5\frac{1}{2}$ feet length of 8-inch pipe laid horizontally, and connected with elbows to the tops of a vertical 8-inch inlet pipe, and a vertical 6-inch outlet pipe. The inlet and outlet pipes were about 8 feet long. A valve was placed at the lower end of outlet pipe to control the flow.

The static pressure on the supply mains was about 75 pounds. An air compressor was used to displace the water in the horizontal pipe and in about half of the 8-inch vertical inlet pipe.

Several tests were made and each one indicated that an average velocity in the 8-inch supply pipe of about 2 feet per second removed all air from the pipes.

Except where easily protected and made readily accessible for operation, any advantages there may be in having an automatic air valve on a bridge are more than offset by the difficulties in protecting and maintaining it in working order.

Almost every winter we have had trouble with air valves on bridges which were left in service. Instead of attempting to repair them, they have been removed and so far there has been no evidence of ill effects resulting from their removal. On all our bridges there is a daily demand ensuring a velocity in the pipe sufficient to remove all air. On an ordinary distribution system the accumulation of air at a high point will not interfere with the flow to an appreciable extent. Where very low heads only are available, an air valve at a high point is, of course, necessary, but my present opinion is that there is no serious consequences to be anticipated from the ordinary distribution main being installed over a bridge with a high point without having at that point an air valve. The most serious objection as far as I can see, is that with low velocities, air to a certain extent may accumulate and then be swept out with an increased velocity brought about by a heavy demand and water hammer to a greater or less extent resulting when the air is discharged through the various outlets.

PAINTING AND MAINTENANCE OF ELEVATED TANKS AND STANDPIPES

JAMES E. GIBSON:[5] I am at a loss as to the reason I have been selected to open this discussion as I am in much the same position that a salesman was in approaching my former chief on the matter of paint for elevated tanks and standpipes, when my chief asked him what he knew about paints. He replied that he did not know anything, which is more than most paint salesmen were willing to admit, and it is from the angle of this salesman that I approach the subject.

Needless to say, it is a very important matter to those superintendents and managers who have such structures under their charge. Painting and maintenance of these structures are dependent upon so many factors, such as location, climate, conditions of operation, for instance, that it is hard to lay down any but the most general conclusions.

The maintenance of these structures depends somewhat upon location—city or urban, industrial or residential. For instance, a standpipe or elevated tank erected in an urban, residential territory would certainly require painting less often than a similar tank erected in an industrial territory where it would be exposed to the smoke and gasses of the manufacturing plants. Secondly, a standpipe or elevated tank located in the interior of the country where the climate is relatively dry, with low humidity and absence of fog, would undoubtedly be lower in maintenance cost than a similar structure located in a humid climate subject to fog, or along the sea coast subject to the salt atmosphere.

Climatic conditions would also play an important part; that is, whether structures are located in warm and temperate, or cold climates subject to great extremes. In the cold latitude protection must be had from freezing, and the matter of maintenance becomes of grave importance, particularly the care of small leaks occurring during the winter time. We have record this last winter of a tank in central Ohio where a small leak occurred, the trickling stream of water freezing on one of the supporting columns, causing it to buckle with collapse of the tank. In southern climates where the standpipes

and tanks are exposed to long continued hot weather, the maintenance due to painting is materially increased.

PAINTING

The painting of standpipes is relatively simple. For flat surfaces easily cleaned and relatively free of inaccessible places, and if maintained structurally tight, painting from three to five years on the exterior will probably give good results. The interior is a more difficult and serious problem. The maximum deterioration usually occurs along the water line, and if the water fluctuates over a wide range and for a considerable period of time, the interval of painting will probably be longer than if the fluctuation is over a limited range and rapid as to period of time; that is, if the tank or standpipe is full, say, only once a week and is drawn down a maximum of half its total height during this period, then the condition of service for the long life of the paint is probably better than if the tank fills two or three times a day and is drawn down only a few feet at a time. This is based upon the assumption that deterioration is concentrated over a limited area in the latter case.

To repaint the interior of a tank it requires that the tank be empty for a number of days to permit the shell to be thoroughly cleaned and dry before the paint is applied. This probably explains more than any other one reason the neglect of the maintenance of the interior of standpipes and elevated tanks. Therefore, it behooves the engineer or superintendent having such structures under charge to consider a permanent form of interior paint or protective coating. On our two million gallon tank at Charleston we gave this matter careful throught with an ultimate decision to use bitumastic enamel, made and applied by the Wailes-Dove Hermiston Corporation. After the plates had been thoroughly cleaned of all grease, dirt, and mill scale, the tank was painted with a neutral liquid bitumastic compound after which the hot bitumastic enamel to a thickness of approximately $\frac{3}{16}$-inch was applied by swabs. It does not give a very smooth coating, but our observation covering a period of four years indicates a very satisfactory result.

The possibility of lining standpipes and tank with a thin cement mortar offers many desirable features. I know of no elevated tank or standpipe receiving this treatment, but at Birmingham, Alabama, the water company have lined their steel filter shells with about $\frac{1}{2}$-inch of cement mortar. Previous to this treatment they had to clean and

paint these shells from once to twice a year, with very indifferent success. Since lining the shells with a cement mortar, now some three years, they have had excellent results with no difficulty due to the cement lining spalling off, and the maintenance of the interior of the filter shells has been reduced to a minimum. The cement mortar shows no deterioration during the three year period so that it would seem possible that cement-lining of standpipes and elevated tanks may be practical. Filter shells are about 16 feet in diameter.

PAINTING ELEVATED TANKS

The nature of the construction of the supporting columns and lateral bracing of elevated tanks should be given careful thought. Columns made up of channels, eye beams, or other structural forms latticed together with lacing or solid plates are generally inaccessible, with many places difficult to get into for cleaning and painting. The columns are usually too small for a man to get inside of and therefore offer a premium for inefficient cleaning and painting. Where the columns are large enough for a man to get in, this objection is somewhat overcome. Solid plates on the exterior side with a minimum of lacing or latticing on the inside of such columns are better than all latticed columns, but in our judgment, the best structural form of all is the Bethlehem H-Section or the deep eye beam section now manufactured by the Carnegie people. These shapes give straight, flat surfaces, readily accessible for scraping and cleaning. The juncture between the supporting column and the tank shell in elevated tanks offers another serious and difficult place for repainting, and considerable thought can be given to this portion of the design so as to eliminate as far as possible inaccessible pockets which hold moisture, and where such pockets are unavoidable, to completely fill them with paint, or better still, with cement mortar. It is even warranted to use surplus metal at these points so as to prevent such pockets. Needless to say, wherever such surplus metal is used, the space between the surplus metal, plates, columns, etc., should be thoroughly cleaned and painted with a good preservative paint such as good red lead in oil before the structure is riveted together.

Paint

I hold no brief for the paint people. I believe there are a number of good paints on the market, but, speaking generally, I believe it is accepted practice that the best material for exterior painting is an

inhibitive material such as red lead in a neutral vehicle of raw linseed oil. This preservative coating should not be placed until the metal plates of the tank or standpipe are thoroughly cleaned of grease, mill-scale, adhering dirt, rust, or other foreign matter, and, if necessary, sand-blasting may be warranted, in which case, the paint should be applied as soon after blasting as it is possible, and before the bright surfaces have a chance to oxidize.

Over this preservative coating of red lead there should be applied a protective coating to protect the red lead from mechanical injury and chemical change. There are a number of paints recommended for this service, all of which have their good features. In our large tank at Charleston, we used for this protective coating metallic aluminum paint in a varnish vehicle, in a proportion of two pounds of the powdered aluminum to one gallon of vehicle. This paint must be mixed as required, and when mixed in the above proportions will have the consistency of cream. It must be applied immediately and well brushed out. The tank has been in service now for four years and while we would like to give it a renewal coat of the aluminum paint this year we will probably not get to it before the Spring of 1931.

Some parts of the elevated tank and standpipe are difficult to maintain well painted. I refer to the step treads and the balcony platforms where the rain water will collect in the depressions of the plates due to inefficient drainage. Then the abrasions due to the use of the steps and walks keep the paint rubbed off. This use is not frequent enough to keep the plates polished, but still it is sufficiently frequent to keep the rust kicked off, exposing new metal for the action of the elements.

Workmanship

As before stated, I think there is nothing better than good, pure red lead in raw linseed oil, followed by a protective coating, but no paint, however good or however lasting, is of much value unless the workmanship of cleaning and applying is thoroughly, honestly, and efficiently done; so the crux of the matter of painting standpipes and elevated tanks comes down to the honesty of the painter. The cost of the material is of minor consideration and therefore it is advisable not to stint the contractor on the labor end of the job. Expert painters should be employed, but if they are not honest and conscientious in their efforts, inexperienced painters may be better. The difficulty with the inexperienced painter is that he will tire more

rapidly than the experienced painter, and further he fails to recognize the necessity of doing a thorough job and then the necessity of brushing out the paint so as to get an even and thorough covering of the surface. This is a part of the painter's art, and it must be conscientiously done.

Inspection

Inspection of all such structures should be continuous, but occasionally, every six months or a year, a critical and through inspection should be made of these structures. In general, good maintenance can be had by painting at about three-year intervals, and under exceptionally good conditions, five-year intervals may obtain. I do not mean to say that standpipes and elevated tanks cannot go longer than five years without painting for I have seen tanks that have not been painted for fifteen years. While they were apparently tight—not leaking—they were not what I would consider well maintained.

Material

The selection of material of which the tank is to be built is important. We all have a high regard for old wrought or Swedish iron made by the earlier generation of iron masters, and when we look around and see the structures made of this material we marvel at their life. As an instance, we have a standpipe in Charleston that was built in 1880 of wrought iron. It was erected on a 14-foot high brick foundation and did service as a standpipe from 1880 until 1905. It then lay idle from 1905 to 1919, during which period it was empty and received no attention other than possibly one coat of paint on the outside for appearance's sake. In 1919 we cut this tank apart and moved it to the pumping station some 13 miles from the city and reerected it, and are now using it as a wash water tank. We used all of the original plates except the bottom ring and the bottom plate which had pitted and rusted so badly that they were next to useless. This tank is doing excellent service after 50 years of life, 14 of which it was out of service and exposed to the elements without attention or care.

In our new two-million-gallon elevated tank, after careful investigation, we adopted the use of copper bearing steel. This tank is exposed to the salt air, and we thought the difference in the cost of the copper bearing steel over the ordinary steel (approximately $2.00 per ton) was well warranted.

As already touched upon, in northern climates subject to severe

cold weather, the heating system and insulating protection for standpipe columns, inlet pipe, and overflow pipe, necessarily increase the hazard and cost of maintenance. These adjuncts should be given careful attention at the beginning of each cold season, and at the expiration of the cold weather they should be thoroughly overhauled, painted, and repaired so as to be in good shape for the coming season.

The question of overflow pipe in winter is particularly necessary as neglect here might cause failure of the tank. Ice conditions in the interior of the tank should be given careful consideration. In a large elevated tank in western New York, where the tank was not in service for a considerable period of time, measurements of the ice thickness formed in the tank were made. This tank had a riser pipe 10 feet in diameter, ellipsoidal bottom, vertical shell, and as I recall it now, there was as much as 18 inches of ice formed in the shell of this riser pipe. No serious damage occurred, but it is conceivable that it might be possible to rupture a tank under these conditions. For purposes of argument assume a tank having a ring of ice, say, 18 inches in thickness; then a few succeeding days of moderately warm weather with bright sunshine. The ice on the southern exposure of this tank would probably thaw during the day time and then freeze during the night, thereby exerting high tensile strain in the shell with the ice acting as an arch. It is conceivable that the continuous action of this thawing and freezing could utlimately rupture the plate of the shell.

Some of us may remember the number of failures of tanks in the early '90's, and a series of articles by William D. Pence of Chicago in Engineering News covering the design of standpipes, and attributing these failures in a number of cases to ice. The recent practice however is to design much larger tanks, and tanks of 1 to 1.5 million gallons capacity are not uncommon today, and necessarily these tanks are from 40 to 60 feet in diameter and the danger from ice near the top causing collapse has been reduced. Our two-million-gallon tank at Charleston is 80 feet in diameter.

BEAUTIFYING GROUNDS

While the grounds surrounding elevated tanks and standpipes are not necessarily a portion of the upkeep of the tank proper, their upkeep is important and should not be neglected. Our early water works practice was to locate such structures near the pumping station and therefore little or no objection could be had upon the part of the public. But the present practice is to locate tanks and standpipes

near the centers of distribution, and this is the more logical practice. The former practice was figuratively putting the cart before the horse. Present day practice means that the tank or elevated structure many times must be placed in the business and residential sections of the city. They are objected to by the public as being ugly and unsightly in appearance and therefore the grounds and surroundings must be beautified to camouflage, as it were, the structure itself. If this is carried out in a proper manner I feel that no objection can be had to the structure. Painting the tank in colors harmonizing with the surroundings and in tints and shades to minimize the contrast on the background of the sky is justified. The planting of shrubbery and the maintenance of the grounds around the tank can be such as to remove criticism and also hide the skeleton structure of the columns in the case of the elevated tank. This will do much toward removing the criticism of the public, and, in fact, I have seen a number of structures in residentail sections of the city where the grounds were so maintained that they were really a beauty spot in the neighborhood.

Mr. Fenkell has a number of these structures in and about Detroit, and Mr. Pirnie has built a number of tanks in his practice in Florida. I am quite certain that, if present, these gentlemen can add considerable information regarding the maintenance of this class of structure.

MR. MORRISON: I would like to ask Mr. Gibson what the thickness of plates and the depths of the pits were in this tank that is fifty years old.

MR. GIBSON:[5] The heaviest plate was $\frac{1}{2}$- and the thinnest plate $\frac{3}{16}$-inch. It was built with the idea of an ornamental effect. The top two plates were flared out. The tank was 18 feet in diameter and the top plates were flared out a foot and a half, making it 21 feet. The bottom and the bottom ring were set in a concrete base covering the entire bottom riveted joint. As I stated in the paper, the tank was allowed to lie idle from 1905 to 1919 without any water in it at all, and where the concrete came up on the bottom ring plate the inside of it was always moist. There the metal had been eaten away until you could in many places see pit-holes right through to the outside, and there was no difficulty at all anywhere in this $\frac{1}{2}$-inch plate from the bottom up for about ten inches that you could not take an ordinary pick, and with a fairly light blow drive the point of the pick right through the shell, but the next shell plate 4 feet above

seemed to be in fair condition and we found no pits that were over ⅛-inch deep in any of the plates. The tank was made of wrought iron plates and wrought iron rivets. We cut the tank down plate by plate, hauled it ten miles and reërected it, putting in a new steel bottom, using steel rivets. We have had no trouble with leakage, although some of those plates are stressed beyond what we would consider good practice today. We use the tank as a washwater tank and it is doing excellent service. It has been in service as a washwater tank down there now since 1920. We have painted it three times, I think, in the ten years. The last time it was painted was a year ago, so it is about five years between coats. We cannot paint the inside of the tank below about 50 feet. The tank is 72 feet high so we can only draw it down about 50 feet, then we have to stop and let it fill up again. This method of painting inside is to clean a few square feet each day and paint this area right away, let the paint harden if it will, and then filling the tank so as to be ready to wash the filters at the next interval of washing.

A. E. MUNYON: What are you using for painting the inside of standpipes? Does the painting give any taste or other effect to the water.

MR. GIBSON:[5] Won't you give us your experiences, Mr. Doane?

A. O. DOANE:[9] Our experience has covered about 30 years and several different standpipes varying from about 35 to 100 feet in diameter, one being 65 and another 43 feet high. We have tried in the early days several different kinds of paint, but we have finally settled down on red lead, and oil for the inside and a priming coat of red lead on the outside covered with some other kind of paint, generally white lead, tinted gray or some other color to give it a good appearance. All of our tanks are enclosed in masonry structures because they are almost all in parks or in some other place where appearance is greatly to be considered. That, of course, helps out a good deal in the life of the paint.

Considerable trouble on the inside of the tank is caused by ice that goes up and down. That has a tendency to scrape off anything that you can put there, whereas in a closed tank the ice is not over 3 to 5 inches thick in quite a severe winter. In some of our tanks before they were covered it used to be 18 or 20 inches. It makes quite a dif-

ference. We have used a certain formula for red lead paint now for a good many years and we find that it will last about ten years on the inside. On the outside, of course, we do not use the same formula. We have one comparatively small tank, in a pumping station. It has been about seventeen years since that was painted. It was painted on the inside with two coats of red lead and one coat of Gilsonite asphalt varnish. It needs painting now, but it is not really very bad. In the case of other tanks, after about 8 years we find that they have developed quite a lot of small tubercles, on the inside surface perhaps from the size of a pea to the size of a lima bean, and at the root of those tubercles are small pits corroded into the steel perhaps $\frac{1}{32}$-inch in depth. These tanks are made of steel, just common soft steel, not copper bearing or with any other alloy. The paint that we used on the iniside is made in accordance with a formula which we have used for a great many years. It is mixed with a certain proportion of litharge. At first we used dry red lead that naturally had some litharge in it and we added a little more. We now use Baste red lead. We did not devise this scheme of putting litharge in the paint, but got it from the United States Navy. The litharge in the paint seems to harden the film and it dries more quickly than when red lead is used alone and it also makes the paint very much more resistant to the softening action of the water.

Mr. Gibson brought out very well that the foundation and the workmanship were two things that were of the utmost importance. The paint film requires a foundation just as much as any engineering structure and if you try to put it on over loose scale or rust or on anything that is liable to loosen, it will come off and the paint will come with it. We find it necessary therefore, to clean the tanks thoroughly.

We do not favor painting the plates at the mill as in the fabrication of the tank the mill scale is loosened under the paint by the action of air hammer used in riveting, thus causing the paint to come off. After the tank is built we clean it thoroughly by sand blasting or by scraping and wire brushing. I suppose that nothing does as gooda job as sandlbasting. That will take the mill scale off whereas scraping and wire-brushing will not take off all of the hard mill scale. We have had tanks done both ways and where they have not been sandblasted they have done very well.

Another feature of sandblasting is that it makes a very smooth surface, so much so that it is hard to have paint thick enough so it does not run badly. If you are putting on any form of hot coating it is

quite difficult to make the coating adhere satisfactorily, whereas the wire-brushing and scraping tends to make a little rougher surface and it holds the paint a little better. The theory that a good many people have, even some painters, that it is a good thing to paint over rust because the rust will hold the paint better is a mistake. It might for a while, but I do not think the results are liable to be satisfactory in the long run.

MR. MUNYUN: Any effect as to taste or odor?

MR. DOANE:[9] We do not find that there is much trouble with paint that we use. We generally wash it down or, if it is at all possible, we put the water in and let it stay for a little while and then just drain it out and we find that once is sufficient. I do not think that causes any objectionable taste or odor. I have heard no complaints. Of course, there is another method as Mr. Gibson said, and that is to have the tank coated with bitumastic enamel. There are several other hot coatings on the market and those coatings do quite well, in fact sometimes very well. In some cases, on the other hand, they fail just the same as in painting. You will find that in painting some people will say, "Oh, well, it does not work out well," but, when we examine it there may be quite a number of troubles. Exactly the right materials may not be used or the tank surface may not be prepared as well as it might be. Just as Mr. Gibson brought out, if you sandblast you have to paint the cleaned surface quickly as it rusts very soon. On a damp day you will see a red film form almost instantly. Paint which is mixed with litharge must be used within a few hours as it has a tendency to thicken and cannot be brushed out satisfactorily.

I have found that it is a good plan to have as large a proportion of pigment to oil as it is possible to brush out to a thin coating; it is more work to apply this thick paint properly and it is pretty hard to get the men to put it on right. If you do not watch them they will thin the paint with anything that comes handy. They like to put in turpentine, but they will use gasoline, kerosene, or anything else to thin it and make the work less for them, and this practice causes a great many failures. It is a case of preparing the foundation, getting the right material, putting it on right and having somebody see that it is done properly.

MR. CHASE: It might be of interest to tell you some experiences we have had in the last year. I am employed by a company which oper-

ates gas, electric, water and railways companies, and we have been painting our water towers in the past with a cheap asphalt or tar paint. We used to paint our gas holders the same way. We had some very sad experiences. We have one 3,750,000 holder, one 2,500,000 holder and one 1,000,000 and another 1,200,000 gallon holder. We painted these holders with a tar paint which was a mixture of turpentine and a few other ingredients. We cleaned one of these tanks last year, the 3,750,000 tank and expected to paint it. Instead of costing us from $6,000 to $10,000, before we got through we spent $27,000, taking off the old coating of paint and we had to sandblast, not only the tank but also the top. We are absolutely cured of any paint of that nature. We have gone back to red lead and oil and on the outside red lead and oil and a blue lead base and aluminum on top of that. I was interested very much in the inside painting, but we certainly learned a very sad lesson on using a cheap tar paint.

C. M. CROWLEY:[18] It occurs to me that the remarkably long life of the old tank described by Mr. Gibson may be due to the *open hearth* iron in common use in the early days.

In the spring of 1904 I had occasion to examine some rusty barbed fence wire which had been used for 23 or 24 years and coiled up on the rear of the lot for 12 or 15 years as scrap. After stringing out 50 or 60 feet I was surprised to find it rusty, but still as tough as ever and that the barbs were as serviceable as when first installed. As I heard farmers complain of the short life of the newer galvanized product, it then occured to me that the bessemer iron had been introduced during the interval. I spoke to the superintendent of a railroad shop of my discovery and urged him to take the question up with the experts at headquarters as it was a vital question involving bridges and other structures. Some months later our then postmaster wrote to me stating that he had received complaints from Washington of the large number of angle iron supports for mail boxes which had to be replaced. I repeated the story to him and urged him to take it up with the Government experts as it was a national question, involving bridges used in interstate commerce and other steel structures. I also repeated the statement to a postal inspector who called on me a short time later.

[18] Water Registrar, St. Paul, Minn.

At a later date I was informed that in 1905 the railroads decided that they could no longer delay placing orders for railroad rails which has been withheld because of financial conditions. As the story came to me, they insisted on open "hearth rails" for which the steel companies demanded $10.00 per ton over the old rail, giving as a reason that it would cost that to rebuild their furnaces. As I understand it the mills and furnaces, built a few years later at Duluth, were constructed to produce "open hearth" steel, so the question is now past history, although it may be interesting to the farmers who had to pay for two or three replacements of fence wire. I do know one steel bridge built about 40 years ago and recently replaced by reinforced concrete that had become so decayed under the sidewalk that one could see daylight through some of the stringers. It looked more like an empty honeycomb than a steel structure. It was replaced none too soon. No doubt many of the older members of this Association have had experience with that type of product.

Fortunately cast iron pipes over or under ground are not subject to the same defect.

E. O. SWEET:[19] Our steel filter tubs as stated by Mr. Gibson, are 16 feet in diameter and were first scraped so as to get any loose scale and tubercles removed, and then the inside of the tubs were sand blasted to get a bright surface. After this the cement coating of the same mixture and material as used by the American Cast Iron Pipe Company in cement lining cast iron pipe was applied with the use of a brush to the inside surface of the tank and to ali troughs.

The cement coating was put on to a thickness varying between $\frac{1}{8}$- and $\frac{1}{4}$-inch and has been found to adhere very closely to the steel plate.

After applying the cement coating, we found it necessary to cover the steel tub with a tarpaulin in order to delay the drying action and thus prevent check cracking on the lining.

Recently we had occasion to cut out two samples of this cement lining to ascertain the condition of the steel behind the lining and it was found that the metal was still bright where we removed the cement coating.

I would not hesitate to recommend the lining of tanks or standpipes with the coating similar to that used by us on the steel filter tubs.

[19] The Birmingham Water Works Company, Birmingham, Ala.

It would make little difference whether the top 8 or 10 feet of the tank were constantly full of water or not, provided the tank had a covering in order to retain the moisture.

I have had no experience whatever with cement lining other than where in contact with water. I would hesitate to recommend the cement lining on the outside of the filter tubs, tank or standpipe.

Before cement lining our steel tubs at Shades Mountain, several different kinds of paint were used on the inside of the tank, none of which successfully kept the surface coated for a period beyond 6 months to a year.

In my opinion it is not necessary to sand blast before applying the cement lining provided that all scale is removed by scraping and the balance of the surface is thoroughly cleaned by wire brush.

ASSESSMENT FOR WATER MAINS AGAINST FRONTAGE

C. D. BROWN:[20] Discussion of this topic immediately raises the question of rate structure. The operation of any water works necessarily depends on revenues, and these revenues may be the result of various systems of assessment. In the year 1925, this Association received some three hundred replies to a questionnaire on the subject of rates, and of this number, seventy cities used special assessments against frontage to raise revenues. Some of these cities charged the whole water main construction cost to frontage, others only a portion, the assessments running from 10 cents per foot frontage per year to as much as $2.00. The latter item, no doubt, represents the gross amount being paid at one time.

Those who may be interested in this subject will do well to read the report of the Committee on Meter Rates, published in the *Journal of the New England Water Works Association*, Vol. XIX, 1905. This report is also found in Mr. Allen Hazen's book on Meter Rates.

The report referred to suggests that the service charge for each consumer be based on the individual property frontage, and where water is used, there be an additional charge for the quantity metered. Such a schedule would be exceedingly equitable, and while it might prove cumbersome, has much to be said for it.

While such assessments may be possible in municipally owned plants, the same procedure could not be enforced by privately owned water works. Nevertheless, I believe vacant land should be assessed for some amount, even where the plant is owned by a private company.

A few years ago, my Company was granted a new rate schedule, which provided for revenues from water consumers under two principal items of assessment:

1. A minimum charge based on the size of the service and including all the plant fixed charges.

2. A general rate based on the cost of filtering, pumping, and incidental expenses.

[20] Manager, The Walkerville Water Company, Walkerville, Ontario, Can.

Undoubtedly, the first or minimum charge includes the item of interest and depreciation on plant, meters, etc; that is, it really provides for the pipe line investment for an average lot frontage. It also included a quantity of water.

Other revenues are received from the municipalities for fire protection, and a special assessment is levied against *vacant frontage.*

In the discussion of this question, I would like to have you feature the assessment against *vacant* frontage. In new real estate developments, the water mains are usually the first improvement undertaken, so that for years possibly, there will be much vacant frontage along the pipe lines, and, therefore, no revenue for water sold.

In determining what should be a reasonable assessment for vacant frontage, a rate per foot equal to the fixed or carrying charges of a 6-inch main would seem fair. Where fire protection pays a rate based on property values, some deduction should be made from this rate, and, if the pipe lines are taxed by the municipality, some amount must be added.

You may have some streets with a water main on each side, resulting in a greater capital expenditure for the water works, but considerable saving in service pipes; however, I believe it better to adopt one frontage rate for the whole system, than to have several rates to provide for special cases.

Any rate schedule should be as simplified as possible, and while it may not be 100 percent equitable, it is better to have a slight inequality here or there, than to have a rate which is so cumbersome or complicated that the average ratepayer cannot understand at a glance, how his bill is made up.

SOME NOTES ON THE PRETREATMENT OF EVAPORATOR FEED WATER[1]

By Hugo A. Haupt[2]

A visit of the author to some of the leading large American power stations has shown the great importance which is duly given in the United States to the pretreatment of the feedwater for getting boilers free of scale and corrosion. In Germany likewise we are for many years of the opinion that only the purest feedwater is just good enough for modern boiler plants.

Evaporators have proved advantageous in such cases where only a few percent of make up are used, the largest portion of feedwater being regained as condensate. But we are of the opinion that in this case the raw-water must be pretreated and softened before entering the evaporator. Only under such conditions a sufficient clean distillate can be produced and any scale forming in the tubes of the high-pressure boilers avoided.

In Germany only five years ago the producers of evaporators opposed the higher initial and operation costs of the evaporators which are connected with such pretreatment. To-day the only controversy is in regard to the most useful degree of softening the feed and the most suitable manner of pretreating.

Some practical examples may show the economical advantages of water treatment which attain a much longer service of the evaporators:

WATER USED	PERCENT REDUCTION OF OUTPUT AFTER		
	3 days	14 days	21 days
Raw-water with about 20 degrees total hardness.		50	
Water of the River Elbe, unsoftened.....	30		50

[1] Presented before the Committee on Boiler Feed Water Studies Session, the St. Louis Convention, June 3, 1930.

[2] Bautzen, Germany.

When using the unsoftened hard water of the River Weser the evaporators had to be cleaned by sand blasting after 300 hours of operation. After removing the carbonate by adding some hydrochloric acid to the feedwater the evaporator had not to be cleaned before 1000 hours of operation, because not till then had the output of the evaporator decreased from 2000 to 1000 kgrs. per hour.

The great success of pretreating the feed is well shown by the following tests performed with *the same feedwater* according to A. Splittgerber:

A set of evaporators A was fed with unsoftened water. Set B was fed by water softened by the lime-soda-process:

GROSS OUTPUT AFTER, WEEKS	REDUCTION OF OUTPUT IN PERCENT OBSERVED	
	In set A	In set B
3	−8	
6	−30	
11	−40	−16
15	−65	−32

In Germany the opinion prevails that the pretreatment must not be carried through as far as it is necessary in the case of high-pressure boilers. The reason for this is given by the fact that the conditions which in high-pressure boilers cause scale forming, priming and foaming by the post-reaction of the remaining hardness with the silica are not to be considered in the case of the ordinary low-pressure evaporators. Pressure evaporators, however, are excepted.

On account of the relatively high solubility of the salts forming no carbonate hardness, only the carbonate hardness must be removed by pretreating the raw-water. Practically the carbonate hardness would be completely deposited on the evaporator surfaces without any residues. The removal of the permanent hardness seems to be less important because in pretreating and evaporating the raw-water without high pressure the sulphates of calcium and magnesium remain in solution during a relatively long time. Otte-Essen particularly referred to the importance of the selective removal of the hardness of bicarbonates and says that this would not be possible with the Zeolite process. Furthermore with the latter process the salt content of the raw-water could not be reduced by the sodium equivalent of the original contents of the calcium bicarbonate of the raw-water.

Theoretically it is, no doubt, possible that the hardness of carbonate

may be removed by the pure thermal method. Practically it is not removed in such a sufficient manner that adding of hardness discarding chemicals should be avoided. Treatment with caustic lime is a simple and cheap method, but has the only disadvantage that proportioning is often incorrect, because the lime saturators practically often furnish in one case a supersaturated and in the other case an unsufficiently saturated lime water.

The so-called "vaccination-process" (Impfverfahren) of the Balcke A.G.-Bochum-Dortmund, Germany, i.e., the conversion of carbonates into chlorides by adding hydrochloric acid has been proved suitable for decarbonizing, although it causes, as in the Zeolite process, a relatively quick formation of salt. But this is of small importance, because the chiefly formed chloride of calcium hardly tends to foaming, on account of its lower viscosity. On the other hand, it is generally known that a surplus of hydrochloric acid is particularly dangerous, as the acid is carried into the boiler system by the steam. Therefore, only so much acid is added that the raw-water shows 0.5 German degrees of initial hardness. Automatic signals are used to prevent an eventual excess of acid.

The objections against the Zeolite process may be justified for water with a high degree of carbonate hardness followed by a quick accumulation of salt at increased costs, even though results achieved by H. Richter in the Berlin power plants and elsewhere are favourable. However, a thin layer of hard scale formed on the heating tubes of the evaporator as long as the water was not completely softened and showed a hardness of 0.2 German degrees. But since the water was completely softened down to 0 degrees, the evaporator showed no reduction of output and had to be cleaned only *once* a year.

The rating of the evaporators being larger than that of a boiler, it is explicable that the generated steam is charged with water particles carried over. By this the quality of the distillate may be affected according to the condition of the evaporator content. Therefore, an effort was made to avoid this difficulty by the installation of plates, but without satisfactory results. It has been proved advantageous with horizontal evaporators to fill the dome with tinplated copper Raschig rings which in the case of vertical evaporators are filled in wire baskets arranged before the evaporator outlet. In such cases where the raw-water to be fed contains many particles in suspension or diluted organic foreign matters it is advisable to pretreat the water by a chemical and mechanical process.

As to whether or not the pretreatment of raw-water to be fed into the evaporators is necessary in Germany today we are of the opinion that, in spite of the costs, the chemical pretreatment is necessary for getting a sufficiently clean distillate containing no more than 20 to 15 p.p.m. deposits and for avoiding an unduly quick drop of the evaporator output. The degree of this pretreatment depends upon the quality of the feedwater. This also is of greatest importance in solving the problem whether continuous blowing down or temporary clearing out of the whole evaporator content is more economical. When the evaporated raw-water is not chemically treated it will be unavoidable to clear down the evaporators in short intervals on account of the increased deposition of mud. In such cases a continuous blow down of 5 percent would not be sufficient.

As the evaporators often are insufficiently dimensioned or improperly operated, some weeks ago the representatives of the large power plant and producers of evaporators in the office of the "Vereinigung der Großkesselbesitzer" came to an agreement by which the following rules concerning the construction and operation of evaporators and the required degree of softness of the distillate were fixed:

Concerning the construction of evaporators the following rules were laid down:

The height and the content of the steam space should be amply dimensioned.

The rating of the evaporating water surface should not exceed the limits given by experience. The arrangement should allow a quick removal and installation of the heating elements.

To secure a thorough cleaning the heating tubes should have a sufficient distance. To avoid longer interruptions of service during cleaning and repairing it is advisable to provide an interchangeable heating element.

The blowing down devices should be arranged according to the local conditions of operation.

For continuous clearing down control-valves should be provided.

An arrangement for regular controlling of the outflowing blow-downs is advisable.

The installation of the required measuring instruments should be provided.

The evaporators should be operated according to the following rules:

The evaporator destillate should not contain more than 12 p.p.m. deposits (at 180 degrees Celsius) and show a hardness of 0.1 degree. Per cubic meter of produced net distillate.....cubic meters[3] must be blown down. The concentration should not exceed.....°Be.

[3] The omitted data are to be given by the producers of evaporators in the offer and can be varied within certain limits according to the local conditions.

The temperature of the.....blow down amounts to.....°C. It should be possible to remove the deposits with simple devices from the heating surfaces. The evaporator body and the heating surfaces shall not show any embrittlements which could produce an early deterioriation of the evaporator.

Before entering the softener the water treated with acid should show a minimum carbonate hardness of 5°. To give warning of an eventual excess of acid an alarm should be provided. The consumption of acid is.....grams per cubic meter of water at .....percent of given acid.

The gas content of the water treated in a deaerator should not exceed 0.1 p.p.m. oxygen. The quantity of water to be blown down from the evaporator at a concentration of the boiler water of.....°Be.is.....percent of the quantity of fed water with.....percent make up, that is.....percent condensate. The boiler water must be as clear as possible.

During the delivery tests of evaporator installations, showing the fulfillment of the given quantities, the following figures are to be followed:

a) Quantity of fed raw-water.

b) Quantity of delivered distillate (The methods of measurement are to be agreed upon when giving the order according to the layout of the plant, for instance the construction of the condenser).

c) Quantity of blow down and its temperature.

d) Pressure and temperature of the heating steam.

e) Quality of the distillate (hardness and deposits).

In the case of multiple evaporators the distillate of each element is to be tested. The mean value of the different measurements is the guaranteed value.

f) An eventual chemical pretreating plant is only to be tested if the guarantees of the evaporator are not fulfilled.

Sometimes it will also be necessary to remove from the raw-water the organic substances which may slow-down the softening process to an extraordinary degree. This is usually done by the well-known methods commonly used for the purification of river water for drinking purposes.

DISCUSSION

MR. WILLIAMS: We have several evaporators at the Union Electric Company and apparently the American practice is somewhat different from the European. We do not clean our evaporators by sand blast or by removing the heat elements and chipping off the scale. We use a method which is called cracking. The tubes are slightly bowed in the evaporators and when the scale forms to a certain thickness, we introduce cold water and let them cool for a while, and then introduce steam and heat them. That causes the tubes first to contract and then to expand, and the scale pops off. They remove in that way about half of the scale that forms in the tubes and the evaporator is so designed it will get full capacity with half of the tubes exposed. That apparently is different from the German practice.

We also preheat the water before it is delivered to the evaporator

with a lime and an iron sulphate system. The lime is supposed to remove the temporary softness and the iron sulphate is simply to eliminate the mud and clear the water as much as possible. We purposely leave in the sulphate hardness, because we find that gives a very hard scale that cracks off very readily with the cracking process, so we do not want to soften the water completely, as some one suggests might be desirable, but simply remove the temporary hardness and get a very brittle scale which can be cracked off very readily. We crack scale about once a day, contrary to the German practice of letting the evaporator go for three or four weeks and then cleaning it. We clean every day and maintain something like eighty-five percent of the full capacity at all times.

MR. BEHRMAN: I would like to ask how long this cleaning operation takes. In other words, how long is the evaporator out of service?

MR. WILLIAMS: Perhaps less than twenty minutes.

MR. HIKOX: I would like to ask you how hot the water is heated in the evaporator.

MR. WILLIAMS: In order to reduce as much as possible the priming effects and to cut down the strains on the evaporator shelves, it is customary to operate at a low heat level, something less perhaps than atmospheric temperatures; in other words, perhaps 180°. With the evaporator operated at a low temperature, some of the difficulties with scale at high temperature are avoided, and it usually works in very well with stationary heat balance, that is, steam is available at a low temperature, but we can use, and some companies do use, higher pressures than that. We have one evaporator which uses steam at about sixty pounds. I would say it is customary, as a rule, to use steam very close to atmospheric pressure. At some places they use steam less than atmospheric pressure because that is readily available at a central station where they use turbines. They also use steam slightly above atmospheric, and at low atmospheric pressure, when, of course, it is necessary to vent it into a vacuum.

MR. HIKOX: The reason I ask, ordinarily you do not get the sulphate scales at atmospheric temperature.

MR. WILLIAMS: The particular evaporator I had in mind, when I said we were expecting to get a sulphate scale, was operating at about 60 pounds.

WATER RESOURCES AND CONSERVATION OF FORESTS[1]

By Warren E. Darrow[2]

In the preparation of this paper, all credit is due to the patience and long service of the investigators of this subject both in this country and abroad. It is only through such service, and the records gathered throughout long periods that we are able to draw any conclusions. The greatest experiment made in the United States, to ascertain the relation between forest and stream flow, consumed a total of more than 16 years,—8 years for preparation, more than one year to denude a watershed, and 7 years to complete necessary observations. A somewhat similar one in Switzerland covered a period of approximately 15 years actual work, extending over 29 years before the records were obtainable. The American experiment began in 1909 and the records were obtainable in 1928; the European investigation began in 1890 and the records were published in 1919.

In arriving at the truth of the relation between water supply and forests a wide range of economic interests engender differences of opinion, mainly because of the desire to find facts favorable to those interests. However, if action is obtained as a result of scientific observations, the actual values would not only show up in the saving of millions of dollars annually, but the general health and welfare of all our citizens would be greatly enhanced. A well known southern scientist has stated that—"Our health cometh from the hills." We immediately add—"What are the hills without the forests?"

METHODS OF OBSERVATION AND STUDY

Beginning in the eighteenth century, and extending through the nineteenth and twentieth to the present, investigation as to the relation of water and forest growth, has had two distinct trends, operating separately for a long time, only to be combined in the two great experiments already mentioned. These are the *physical* and the *hydrometric* methods.

[1] Presented before the Southeastern Section meeting, April 17, 1930.

[2] Consulting Engineer, Columbus, Ga.

THE PHYSICAL METHOD OF INVESTIGATION

Investigation through the physical method entails comparison of forest areas, and adjacent open fields, with respect to climate, i.e., temperature of the air, temperature of the soil, relative humidity, and precipitation, local and over continents.

It has been found that the temperature of the air is lower by some degrees, within a forest area, than it is without, especially in two vital periods,—the ground water storage period, and the period of least rainfall.

The temperature of the soil is lower within the forest area than in open fields, or fields under cultivation, even in fields containing high corn in the growing period. Further than this, there is an average of 25 percent less fluctuation in soil temperature within forest areas.

In summer time, the moisture content of the air is greater in the forest areas. During this period ground water is fed by seepage to the streams.

As to a comparison of rainfall within and without forest areas, there is not time here to go into the many phases involved. However, during a 10 year test, 22 percent more rain fell within given forest areas, than fell without. Considerable of this percentage is desiccated by means of transpiration, or the water thrown off as vapor by the trees. But it is conserved, in turn, by the lower temperatures and falls as heavy dew, and similar forms of moisture.

CONSERVATION OF WATER

Scientists and others agree that, by the very nature of things, the forests are more favorable for the production of moisture in their own and in areas adjacent to them, than are those sections which have been cleared and are now either agricultural or barren. The question immediately arises, what advantages do these features present in the conservation of water which they evidently induce to be deposited within their influence. Aviators and balloonists have rather consistently reported that a difference of atmospheric conditions is noted at heights of 5000 feet and less, when operating over forests. Weather Bureau officials have recorded the fact that forests act as replenishers to moisture laden air currents sweeping inland, from large water bodies. This would seem to indicate that water is carried away in large quantities. But in the examination of physical conditions a difference is found in the action of forests existing *in level*

country and forests *in the hills and mountains.* In both cases leaf mold and humus (which we might call the natural carpet of the forest) have a favorable effect. In the level country, the forest loses about 65 percent of all precipitation, leaving 35 percent for ground storage and stream flow in dry seasons. As compared with this, cultivated fields or low growing stubble lose from 62 to 80 percent of precipitation leaving an average of 29 percent of storage. These percentages would not appear to show any great advantage to the forest areas. But in the Southeast, it is believed the topography shows great areas as hills and mountains. Here a consistent growth of forest has its most marked effect in the conservation of water for ground storage and stream flow. The forest carpet or humus, aided by the tree crowns receives the average rainfall in a far different manner than does the open field. Even hard storms are received to the soil in stages which break up severity. Tree crowns have the effect of splitting the rain drops; the tree trunks, especially of a pine forest aid in softening the pelting rain; then the carpet performs the function of a sponge, the effect of which is to store water in a most marvelous way. The thicker the carpet, the better. One investigation shows that the ability of the carpet to store water is eight times as great as its increase in thickness. Multiplying the thickness by 2, multiplies its storage capacity 16 times.

Now if we excavate under such leaf mold and humus, there is found a very soft soil, light, and easy to handle. Water can enter this much faster than a hardened surface, uninfluenced by such a covering. The capacity for storage of the humus covered soil is much greater. In addition, the tree roots themselves maintain a cavity-making process which adds to the ability of the soil to store water. As time progresses the mold itself becomes soil, and the depth of the softer, spongier, material becomes greater. It hardly seems necessary to show how utterly such a storage capacity is ruined by fires. The natural watershed reservoir is on its way to complete destruction when fires are allowed to progress. The ashes which are left, soon become dust which is readily carried by the wind, leaving a job of many years length, in replacing the carpet with the original storage efficiency. And in America, the rule at present seems to show, that no carpet is thereafter allowed to be made.

Trees and roots hold this soil on the slopes. If *unwise* cutting is done, erosion starts its march of destruction.

FORESTS AND EROSION

Engineers of France, through years of patient and increasing investigation, have concluded that *forest cover* is one of the most effective means for checking erosion and furthermore that the best locations at which to control stream flow are at the headwaters. They have built impounding reservoirs and have reforested mountains to control torrents and ease the supply of water into reaches below. Before these important decisions were made, some 800,000 acres of farm lands had been ruined in 18 departments before the year 1860, when forest planting was begun at headwaters of streams passing through these lands. Due to water shortage in the most needed seasons, the population was reduced to poverty and the lands were vacated. The French government has reported that 163 of the streams are absolutely under control due to reforestation, 624 more streams are showing the effects of forests on their headwaters, and 31 of the worst and most hopeless streams have become controlled.

Illustrating how destructive are waters, when flowing in a stream bed, uninfluenced by forest cover in its watershed, investigation has shown that it is possible for detritus, silt, sand, gravel and even boulders to be carried along at the rate of 2½ cubic feet for each cubic foot of water flowing. At such a rate, you may quickly recognize that naturally fertile farm lands can be covered with unfertile material and that it deprives the inhabitants of the valleys of water supply in the most needed seasons.

Another great cost at which we do not replace our forest growth is well illustrated in the mining regions of Tennessee in the Ducktown area, and on the side of the mountain at Mauch Chunk, Pennsylvania. The fumes from mining and railroad operations have created ugly and useless areas.

In the plains of the Appalachian system the greatest difficulty now facing us is, that any flood of size, brings coarser material into the plains, than did similar floods, previous to 1885. This fact alone prophesies the eventual impoverishment of inhabitants in areas affected, unless we plant and reforest sufficiently to overcome such a march of events. Of the soil which is mentioned above, the forestry department of the United States etimates that 100,000,000 tons is eroded and washed into the rivers and seas each year.

THE HYDROMETRIC METHOD

In turning to the hydrometric method, it is necessary to emphasize that comparisons of streams by measurement of the flow are particularly liable to error. This method is greatly in use for reasons of swift advancement of industrial development and increase in population, and also because many do not realize how inaccurate results may be. However, stream measurement serves many other purposes, when accurately taken. Most stream flow measurements are incomplete, and dependence on them alone leads to more serious difficulties, than when such results are combined with all those of the mechanical or physical method first reviewed herein.

Measurements should be taken over long periods. This country is particularly lacking in such methods for its 290 navigable streams. Less than one-third of them have records extending back for more than fifteen years. Europe has been in the business since 1730, but it has comparatively few reliable records. In records here and abroad, very few accurate statements are available concerning condition of forest-cover over areas considered in stream flow measurements.

A combined record by forestry departments, and geological survey activities, would be of far more value than the single activity of stream gauging for its records alone, as far as proving the value or lack of value of forest growth on a definite watershed. Such a method was used in the case of the American Experiment in Colorado, 1909–1926. It does not seem to have been carried out fully in the Swiss Experiment of 1890–1919.

Effects of the forest vary with the geological formation, topography and size of watershed, and with the depth and character of the soil. The writer thinks soil conditions affected results in the American Experiment considerably, by securing large ground storage subsequent to removal of the forest from one of the watersheds.

It must be kept in mind that we are emphasizing the conservation or control of water, *for all time periods*, and that we are *not* discussing to any great extent the *average flow* or the *total annual flow* of streams which are affected by forest growth. Either the averages or the total might show wonderful quantities of desirable water, but during the time applying to either, the lake, stream, river, creek or springs might be entirely dry, meaning a cessation of water for drinking and manufacturing purposes, or such a reduction in quantity as to cause serious

inconvenience and even peril to individuals and property. Enough of such periods, combined with fire hazards and removal of manufacturing establishments to other locations would soon serve to impoverish the locality affected.

A significant set of facts have been developed with regard to streams emanating in the Eastern plain of the Appalachian System. Forested watersheds yield 61 percent of eight months flow *during three months* from April to June, which they gathered in the storage periods.

Cultivated areas yielded 73 percent and barren drainage areas yielded 89 percent of their total amount of eight months flow.

We recognize April, May and June as fairly good storage periods; therefore, the cultivated and barren areas are storing far less water than areas with forest cover.

EFFECT OF REMOVAL OF FOREST ON ELEVATION WITH GROUND WATER

It will perhaps be of special interest to those who operate well supplies, that the application of these conditions to their means of getting quantity production, is most important, although showing effects more slowly than the supplies taken from the surface. In 1911, Dr. W. J. McGee described a condition which we may expect to have repeated in the South. His investigation has to do with areas which were then extensively cleared of forest growth. During 22 years in the States of Wisconsin, Illinois, Tennessee, Ohio, Michigan, Minnesota, Kentucky, Iowa and Indiana, 9,500 wells indicate a lowering of 1.3 feet minimum in the water table, all corresponding to 13.8 feet in 80 years. He states that the lowering is due to quick run off, increasing as the time progresses. In the record are entries showing the disappearance of springs and smaller source streams. The regimen of nearly all streams has been deteriorated.

THE TWO OUTSTANDING EXPERIMENTS WITH HYDROMETRIC METHOD

The Swiss Experiment in stream gauging has been mentioned. Some call it the most careful and conclusive evidence of the influence of forest growth upon the regularity of stream yield. Two comparatively small watersheds, one containing 140, the other 175 acres, have been made the basis of the experiment. Topography and surficial characteristics, geology, soil, and latitude were selected as near alike as it is possible to find them. However, one was covered by forest almost entirely; the other was 70 percent vacant. Rainfall, precipi-

tation, run off measurements, and temperatures all were carefully recorded. Responsible and trained men had the work in charge. As a result, thus far, it is found in high water periods that the deforested watershed causes the stream channel to carry 30 to 50 percent more water per unit of area than does the forested watershed. After periods of drought the springs of the deforested area, dry up and the stream bed is dry, while the stream bed of the wooded area still yields water. The investigator finds that the forest benefits the streams by equalizing the flow in dry and wet periods, without diminishing the total annual yield. He finds that the total amount of water discharged remains the same per unit of area of watershed.

The American Experiment at Wagon Wheel Gap, Colorado, is one of the very few of its kind in gauging the flow of streams in America. Similar to the European investigation, two watersheds were selected of small areas, and of quite similar characteristics with the exception of one particular and important feature. One watershed was shaped more as a rounded basin. The other was very much elongated as a funnel. The areas were very nearly the same, 200 and 222 acres, one being 7300 feet long, the other 4600 feet long, the one of greater length being of less width by 570 feet. Being adjacent and boundaries touching the other, the precipitation could not vary to a great extent. Height and temperature were very nearly equal. Dams and equipment were so built, that their measurements might be read automatically, and silt taken out and measured three times a year.

The difference in operation, between the American and the European method, occurs in cutting the forest after the first period of 8 years observation on one of the American watersheds. As the Swiss Experiment is understood by the writer, no cutting was done and no diversion of years in the experiment were taken into account. The Swiss Experiment recorded the wet and dry years stream flow.

However, it must be noted that during the 7 years after denuding the forest at Wagon Wheel Gap, small trees grew to the height of 4 feet. In the report this significance is not mentioned as a reason for the maintenance of storage possibilities on the denuded watershed. The writer believes that greater stream yield is also caused by the greater distances that ground water had to travel, as compared to the watershed whose forest remained intact.

Before the forest was cut, the two areas produced the following percentages as run off, 28.9 and 29.3.

After the forest was cut, the runoff produced is recorded as 0.293

and 0.349, the greater being had from the denuded area. However, these are *all time averages only*. One would expect much irregularity where the forest was cut.

The annual excess flow from the deforested area equaled 0.96 inch. But the silt carried by the stream increased from 5 to 15 times as much as it was before the forest was taken off. Throughout the experiment, the soil conditions were so very good that little water appeared as a surface runoff; therefore, erosion had only just begun when the experiment was brought to a close. The report states that the soil conditions on both areas afforded exceptional ground storage. No credit is given the forest for aiding in storage, and from records shown this appears partly justifiable; however, no forecast is made as to the disasterous effects of soil removal by erosion when allowed to get well under way, say for another 5 to 7 years.

By deforesting, the ratio of high stages to low stages of stream flow was increased from a proportion of 12 to 1 to that of 17 to 1. It seems to the writer that those responsible for the Report on the Wagon Wheel Gap Experiment, rather reluctantly admit that increasing ratio of flood or high water occurrences are a sure indication that every agency is needed for protecting the soil from erosion. In other words, the forest must be preserved to prevent erosion of soil, the function of which is to store up water and feed it out in seepage when most needed.

STATUS OF FOREST PROTECTION IN THE SOUTHEAST

Up to 8 years ago only two states, represented in the Southeastern Section of the American Water Works Association, had provided any appropriation for forestry activity looking to the protection of trees and soil in the forests. When this protection is thoroughly provided for, water conservation at the source will be well taken care of.

Since 1922, most states have passed reasonable but passive forestry laws. Political expediency would seem to control rather than safe and sane reasoning in preserving the younger tree growth.

STATE APPROPRIATIONS

The report of one state for 1927 and 1928, shows an increasing amount provided for forestry purposes. The total fund from January 1, 1928, to December 31, 1928, was credited with $58,165.00 as State and $55,685.00 as Federal appropriation, making a total of $113,850.00. Of this amount only $4,018.00 was expended for

forestry planting. However, $70,414.00 is credited as being used for forest protection, as it should be. It would seem that larger and larger amounts could be apportioned for tree planting and care, especially on the watersheds of our most important water supply sources.

In present methods of cutting and hauling, the introduction of fast hauling truck and trailer, during the past three years, has depleted much of the thinner growth lying nearer the centers of population and has no doubt affected the condition of present or proposed water supplies.

SUGGESTIONS FOR REMEDIAL ACTION

Coöperation and joint action with the farmer to prevent erosion losses.

Seeking coöperation of the saw mills with the Federal Forestry Bureau and legislation.

Appropriations, federal and state, for intensive and widely active reforestation. Up to 1922, there were no state appropriations available in Mississippi, Alabama, Georgia, Florida and South Carolina.

Education should be extended to reach those responsible for doing away with the trees, and for a large part of the destructive work. Purchase or lease whole watershed area and reconstruct the area by reforestation and fire guards or lanes. Make it a duty for the water superintendent to ascertain what diseases or other causes are thinning out tree growth, and be responsible for remedial action.

As a result of careful hydrographic surveys, and recommendations from a board of engineers, various governments in the world are beginning to enact laws prohibiting the destruction of forests, outlining how lumber operations shall be carried out, limiting the cut to sizes and kinds; in general, exercising police, warden or ranger powers to preserve forests.

In democratic America, we are much slower. Records of the Federal Bureau of Forestry are worth the attention of the best and the most constructive thinkers in the water works field. Destruction of forests is proceeding at a rate four times as fast as the present growth. They show that under crude forestry the growth can be brought up to one-half the amount cut annually; they also show that under reasonable regulation and reforestation the drain on forest growth can possibly be overcome and exceeded by an 8 percent increase. This reasonable regulation cannot be accomplished by police

power alone, but by obtaining the coöperation of lumber men and farmers, railroads, automobile tourists, water works men, power companies, and in fact all who are so vitally interested in the problem.

In spite of the general impression of the timber land owner of the United States that he can destroy as he deems best, it is recommended that legislation be adopted especially in the Southeastern states to prevent further destruction of the pine and provide appropriations for reforestation intensively.

DISCUSSION

C. A. WHITTLE.[3] Forests exert important influence upon the available supply and quality of water. They increase the water of percolation and reduce the surface runoff. Water of percolation is, of course, cleaner and purer than surface water and is preferred by those whose duty it is to provide desirable water for towns and cities.

How forests conserve water. When rain drops fall on a forest they strike the leaves, limbs, twigs and trunks of the trees. The impact breaks the drops into smaller particles and reduces the force of their fall on the ground below. This leaves the forest floor looser and more absorptive than if the rain drops spent their force pelting it.

With the rain drops broken by the forest into small particles the moisture is in a form to be more easily absorbed by the forest floor and less of it gets away as surface run-off.

The chief influence of the forest in conserving rainfall, however, is that exercised by the character of the forest floor. A forest floor thickly covered with an accumulation of litter, leaves and humus is a veritable reservoir. It serves as a check dam and sponge to hold rain water till the soil beneath can absorb it. Then this organic matter of the forest floor serves as a mulch to hold the water in the soil against loss through surface evaporation.

The absorptive power of a forest floor varies with the thickness of its carpet of organic matter. It is least, of course, where the forest floor is burned over. It is greater where the fallen leaves are small, as in the case of conifer forests than where the leaves are large, as in the case of hardwood forests. The forest floors of the north have greater absorptive power than the forest floors of the south because the oxidation or decay is faster in the south than in the north. The difficulty of accumulating humus on the forest floor is also greater where there is abundant rainfall than where there is scant rainfall.

It is a well recognized law of physics that the smaller the soil particle, the greater the water-holding and water-absorbing capacity of the soil. When vegetable matter is thoroughly broken down in the

[3] Georgia Forest Service, Atlanta, Ga.

process of decay, the product is exceedingly small particles, much of which is colloidal in nature. It swells as it absorbs water after the nature of a sponge.

But the absorption of a forest floor is not determined wholly by the humus or residue of vegetable decay. The partially decomposed matter and the undecomposed leaves and fallen twigs and limbs, while affording some absorption, are most useful as check dams to hold water in place till it has time to percolate downward into the forest floor and soil. Still another factor of absorption is the roots, whether dead or decayed, the dead leaving channels for the water to flow down into the soil, or live roots that help water to seep down along their course.

The question of how much water a forest floor will absorb has been attacked by research workers in this and foreign countries. Based on accumulated data, it has been conservatively estimated that each inch of organic matter or humus on the forest floor is capable of absorbing half an inch of rainfall. In Europe, Huffel found that a forest with leaf litter did not give off a drop of surface water even on a very steep slope after a rain fall of 2.4 to 2.8 inches.

Investigations in lake states show that freshly fallen litter of a Norway Jackpine forest would absorb 0.014 inch of water whereas old litter retained an average of 0.17 inch. This emphasizes the importance of keeping the litter on the forest till decay is well advanced, to get the best results.

Another indirect effect of forests on the water absorbing capacity of a soil is the function of the carpet of organic matter of the forest floor in maintaining the permeability of the soil underneath. Where there is no organic coverage the clays or other finer particles of the soil settle into and clog the avenues of percolation. This means greater surface run-off than when a cover of litter protects the soil capillaries from the sealing effect of muddy water.

The rapidity with which a forest floor will absorb rainfall will depend on both the state of decomposition of the liter and its quantity. But there are definite data showing that forest humus and litter thoroughly immersed in water will require twenty-four hours for complete absorption. Under ordinary rainfall conditions forty-eight hours are required for complete absorption. This again emphasizes the necessity of having abundant litter to impound the water till absorption is complete.

Soil evaporation. Much rainfall, of course, is lost to springs and

streams from evaporation at the surface of the soil. This loss is least in the forest where leaves and litter not only act as a mulch to break capillary action in evaporation, but reduce this surface loss by keeping the soil cool and the atmosphere in the forest both humid and cool. Several investigators have reached conclusions that show the evaporation loss in a forest to be 2½ times less than that outside of the forest.

Forest transpiration. It is true that forests themselves make heavy demands on soil water through transpiration processes, taking the water in the roots and passing it off through the leaves and bark. This demand for water is great only during the growing season. Pines transpire less water than hardwoods. Ney computed, for instance, that beech transpire during a growing season 10.8 inches of rainfall and pine 2.9 inches.

During the dormant period when trees require very little moisture is, of course, the period when soils get their main store of water for feeding springs and streams between rains.

Effect on springs. The fact that forests do greatly affect the flow of springs has been attested by many investigations. Grebe cites numerous examples of springs drying up and of reduced stream flow as a result of deforestation in Central Germany.

Numerous instances are cited by the National Conservation Commission of this country of springs and streams drying up as a result of deforestation. The Geological Survey of Georgia cites instances of streams drying up or being lessened in North Georgia in consequence of removing growth.

Similar instances cited in literature on the subject leaves no doubt about springs depending in no small measure on the power of the forest to conserve rainfall for underground sources of water.

Forest fires and water. We have stated that where fires burn the organic matter of the forest floor the water absorbing capacity is low. Just how much do the fires influence the storing of rainfall in forests?

The Southern United States Forest Experiment Station has determined that a forest floor kept free of fire held seven or more times as much as one burned over annually. This station studying the water-holding capacity of long leaf pine litter accumulated for one year (one inch) after a fire to be 0.02 inch; whereas the amount of water absorbed by the accumulation of five years (two inches) was 0.17 inch. In other words, doubling the depth of the litter increased the water-holding capacity eight times.

Recent data in California indicate a surface run-off from forest soils from which litter had been removed as ten to thirty times greater than from soils with a complete mantle of forest litter.

Is it necessary to argue that fires are destructive to the water-absorbing capacity of forest soils and that every precaution should be taken to guard against this enemy of springs, streams and reservoirs?

The effect of burning the forest floor débris is not only to release more and muddier surface run-off but it means that the water is impregnated with the mineral residue of the burned organic matter, principally lime. In some instances, this may not be objectionable, but in limestone regions it may add to the hardness of the water.

Erosion difficulties. Land denuded of forests, as has been shown, releases a larger volume of surface run-off. From the view point of the water works and hydro-electric engineers, much of this waste water is the kind of water that is meant by the old saying, "water that runs over the dam turns no wheels."

But even where the matter of an adequate supply of water is not an issue, excess surface run-off creates serious difficulties for the water works engineers, for it means a problem of dealing with clay and silt in suspension.

Clay, silt, sand and gravel moving in the water add greatly to the volume of freshets. Studies made in France showed that a mountain stream after heavy rain brought down detritus that in volume amounted to 2½ times more than the water itself. The magnitude of floods is not only increased in this way but such flood borne matter fills up stream beds, so that the flow spreads out and intensifies its destructiveness by washing away good bottom land or depositing upon it coarse sand and gravel that impairs its value for agricultural purposes.

The greater the stream flow the greater the velocity and the greater the power of the stream to bear detritus in suspension. According to a law of physics, if the velocity of a stream is increased ten times its transporting power is increased one million times.

Le Conte determined that a current having a velocity of two miles an hour will move stones the size of a hen's egg, and draws the conclusion that a current with a velocity of twenty miles an hour will carry a boulder weighing one hundred tons.

All of which emphasizes the necessity of not allowing heavy releases of surface water, an end to be most economically achieved by reforestation of eroded land and by keeping fires out of lands already in forests. The water supply problem is, therefore, indissolubly joined up with forestry.

GROWTH OF ANAEROBES IN BILE MEDIA CONTAINING MALACHITE GREEN AND BRILLIANT GREEN

By Charles F. Poe[1] and Norman F. Witt[2]

Different anaerobes have been responsible for many false presumptive tests in water analysis. This has been especially true with the Standard Method where lactose peptone broth is used. In this medium most of the common gas-forming anaerobes grow luxuriantly. This has also been observed by one of the authors (1) (2) to be true when lactose bile medium is used. This was found to be especially the case when the higher concentrations of bile were used.

The use of different dyes, notably the triphenylmethane dyes, in media for water analysis has been proposed during the last few years. Hall and Ellefson (3) (4), in 1918, were the first to propose the use of a dye in lactose broth to prevent the growth of anaerobes. They found that one part of gentian violet in 20,000 was effective in eliminating the growth of all gas-forming anaerobes. Wagner and Monfort (5) confirmed the findings of Hall and Ellefson.

The use of dyes in lactose bile broth is of somewhat more recent introduction. There seems to be some difference of opinion as to the value of such media in inhibiting the growth of anaerobes. Dunham, McCrady and Jordan (6) in summing up the work of the Standardization Council Committee No. 1 (Standard Methods of Water Analysis) stated in their conclusions that spore-forming organisms are eliminated by a brilliant green content of 1:10,000. Ruchhoft (7) came to the same conclusion.

Hale (8) in discussing a paper by Dunham and Schoenlein (9) on brilliant green media stated that a dye concentration of 1:75,000 was not sufficient to prevent the growth of gas-producing anaerobes. He stated that a dye content of 1:10,000 was required. In proposing a dye strength of 1:75,000, Dunham and Schoenlein, however, did not claim that anaerobes were entirely inhibited.

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Jordan (10) stated that a brilliant green dye content of 1:75,000 was probably not as good as one of 1:20,000 for the elimination of anaerobes. He found, however, that the former strength afforded sufficient protection in most of the water supplies studied. One of us (2) while working with the crystal violet bile media found that a very high concentration of this dye was necessary to eliminate anaerobes. With a number of cultures of anaerobes a dye content greater than 1:1000 was required to prevent growth and gas formation.

The results presented in this paper show the effect of brilliant green and malachite green media, both with and without bile, on the growth of gas-producing anaerobes.

EXPERIMENTAL

Lactose broth was prepared and varying amounts of each dye, separately, and bile were added. The amount of lactose and peptone were each one percent. All media were adjusted to a pH value of approximately 7.2. Ten cubic centimeters of the media were tubed in Durham fermentation tubes. Dyes in different concentrations were also added to the plain lactose broth.

Suspensions of the different anaerobic cultures to be tested were made in sterile water. Five cubic centimeters of this dilution were added to one tube from each of the different lots of media. The tubes were allowed to incubate at 37°C., and gas readings were made in 12, 18, 24, and 48 hours. In case there was no gas produced in 48 hours, another reading was made in 72 hours. The proportions used were on the basis of 20 cc. of medium and 10 cc. of inoculum. These are the proportions used in routine water analysis. All of the results in this paper are expressed in terms of the amount of dye present in the original medium before the sample of inoculum was added.

The cultures used were mostly obtained from Dr. Ivan C. Hall, University of Colorado Medical School, Denver, Colorado. Three cultures of B. welchii were obtained from F. E. Greer, Department of Health, Chicago. Nineteen cultures, in all, were used as follows: B. multifermentans, two cultures; B. tertius, two cultures; B. sphenoides, two cultures; B. welchii, Type I, two cultures, Type II, three cultures, Type III, four cultures, and Type IV, four cultures.

The growth of the above anaerobes in the different media will be discussed under four headings: brilliant green lactose media, malachite green lactose media, brilliant green bile media, and malachite green bile media.

BRILLIANT GREEN LACTOSE MEDIA

Each of the anaerobes were tested in each lot of medium representing different strengths of dye. The dye content ranged from one part in 300,000 to one part in 1,000. The results obtained from the organisms producing gas in 48 hours are listed in table 1.

As may be seen from table 1 the cultures of welchii belonging to Type II were the only anaerobes showing much gas production. One culture of B. tertius produced 20 percent gas in forty-eight hours with a dye concentration of 1:300,000. All other concentrations fo

TABLE 1

Gas production in percent in brilliant green lactose broth

B. welchii, Type II

DYE CONTENT	A				B				C			
	12 hours	18 hours	24 hours	48 hours	12 hours	18 hours	24 hours	48 hours	12 hours	18 hours	24 hours	48 hours
1:300,000	10	35	45	75	0	5	20	45	0	0	25	35
1:200,000	0	20	30	50	0	0	15	60	0	0	10	25
1:150,000	0	0	25	45	0	0	10	50	0	0	10	30
1:100,000	0	0	10	40	0	0	10	40	0	0	0	25
1:75,000	0	10	15	50	0	0	5	40	0	0	0	25*
1:50,000	0	0	0	25	0	0	0	40	0	0	0	20*
1:35,000	0	0	0	25	0	0	0	30	0	0	0	15*
1:30,000	0	0	0	25	0	0	0	50	0	0	0	10*
1:25,000	0	0	0	25	0	0	0	25	0	0	0	0*
1:20,000	0	0	0	5*	0	0	0	5*	0	0	0	0*
1:15,000	0	0	0	0	0	0	0	0	0	0	0	0

* Twenty-five percent or more gas produced in 72 hours.

dye showed no gas, even in seventy-two hours. Two cultures of other types of B. welchii produced a small amount of gas in seventy-two hours. One culture belonging to Type III gave gas in a dye concentration as high as 1:75,000. The maximum was 25 percent, however. One culture belonging to Type IV gave gas in a dye concentration as high as 1:50,000. The maximum amount of gas was only 10 percent in seventy-two hours. The same thing was noted here as was noted by one of the authors (2) with crystal violet media. The dye media seems to allow the vigorous growth of the members of B. welchii, Type II, and retard the growth of the members belonging to the other types of B. welchii.

MALACHITE GREEN LACTOSE MEDIA

The different lactose media containing malachite green were tested in a similar manner to that containing brilliant green. The results for organisms showing gas in 48 hours are listed in table 2.

A comparison of table 2 with table 1 will show that there is little difference in the growth of anaerobes in brilliant green media and malachite green media. With the latter media, we note that the cultures of B. welchii of Type II were the only ones giving much

TABLE 2

Gas production in percent in malachite green lactose broth

B. welchii, Type II

DYE CONTENT	A				B				C			
	12 hours	18 hours	24 hours	48 hours	12 hours	18 hours	24 hours	48 hours	12 hours	18 hours	24 hours	48 hours
1:300,000	25	40	50	60	15	30	40	50	15	30	40	50
1:200,000	15	30	40	55	0	10	25	45	0	20	30	50
1:150,000	10	30	40	55	0	0	10	45	0	20	40	55
1:100,000	0	0	15	50	0	0	5	10*	0	0	0	25
1:75,000	0	10	20	40	0	0	0	10*	0	0	0	25
1:50,000	0	15	25	55	0	0	0	10*	0	0	0	25
1:35,000	0	10	25	50	0	0	10	45	0	0	0	40
1:30,000	0	0	25	45	0	0	0	10*	0	0	0	0*
1:25,000	0	0	15	40	0	0	0	5*	0	0	0	0
1:20,000	0	0	0	5	0	0	0	0	0	0	0	0
1:15,000	0	0	0	0	0	0	0	0	0	0	0	0

* Twenty-five percent or more gas produced in 72 hours.

gas production. Culture A produced a little more gas in the malachite green media and cultures B and C produced somewhat less. Also there was a small amount of gas produced in 72 hours with this media by two other cultures of B. welchii. One culture belonging to Type III produced gas in a dye content as high as 1:50,000. The maximum amount was 20 percent. One culture of Type 1V gave gas in a dye concentration up to 1:75,000. The maximum amount of gas here was 5 percent. The results here also indicate that B. welchii, Type II is much more resistant to dyes than the other types of B. welchii.

TABLE 3

Reciprocals of brilliant green content required to prevent gas production in forty-eight hours

ORGANISM		BILE, PER CENT										
		1	2	3	4	5	6	7	9	11	13	15
Multifermentans	A	100,000	100,000	100,000	75,000	75,000	75,000	75,000	75,000	50,000	35,000	10,000
	B	100,000	50,000	20,000	20,000	20,000	20,000	15,000	15,000	10,000	10,000	10,000
Tertius	A	100,000	50,000	35,000	35,000	30,000	20,000	15,000	10,000	10,000	10,000	6,500
	B	100,000	75,000	50,000	35,000	30,000	30,000	15,000	15,000	10,000	10,000	6,500
Sphenoids	A	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
	B	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Welchii Type I	A	100,000	100,000	75,000	50,000	35,000	35,000	35,000	20,000	20,000	20,000	10,000
	B	100,000	100,000	100,000	100,000	100,000	50,000	50,000	35,000	25,000	20,000	20,000
Welchii Type II	A	1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
	B	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
	C	1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000	1,000	>1,000	>1,000
Welchii Type III	A	100,000	35,000	25,000	15,000	6,500	6,500	6,500	3,500	3,500	1,000	1,000
	B	100,000	100,000	100,000	100,000	100,000	50,000	50,000	50,000	50,000	50,000	35,000
	C	100,000	100,000	100,000	100,000	50,000	35,000	35,000	35,000	35,000	100,000	100,000
	D	100,000	100,000	100,000	100,000	75,000	50,000	35,000	30,000	30,000	30,000	20,000
Welchii Type IV	A	100,000	100,000	100,000	75,000	75,000	50,000	35,000	35,000	25,000	25,000	10,000
	B	100,000	100,000	100,000	100,000	100,000	100,000	35,000	20,000	15,000	15,000	6,500
	C	100,000	75,000	30,000	10,000	10,000	10,000	6,500	6,500	3,500	3,500	3,500
	D	100,000	100,000	100,000	100,000	75,000	75,000	50,000	35,000	25,000	20,000	10,000

BRILLIANT GREEN BILE MEDIA

Similar experiments with the dye media containing bile were carried out as above. The dye content varied from 1:100,000 up to 1:1,000. The bile content was from 1 percent up to 15 percent inclusive. The results for brilliant green are listed in table 3.

The gas production in the brilliant green bile media showed considerable variation. The cultures of B. multifermentans were inhibited by a dye concentration of 1:100,000 (the lowest concentration used) with 1 percent bile, but when 15 percent bile was used the dye content required was 1:10,000. The cultures of B. tertius showed about the same results. The cultures of B. sphenoides gave no gas production in seventy-two hours in any of the media. The cultures of B. welchii showed no similarity. Those of Type I were satisfactorily inhibited in the lower bile content by a dye concentration of 1:35,000 or less. All of the cultures of Type II were very resistant. A great amount of gas was produced in all of the media with a bile content greater than 1 percent even when the dye content was as great as 1:1,000. The cultures of Type II were also found to be resistant to crystal violet as reported in a previous communication (2). The cultures of Type III and Type IV varied greatly.

MALACHITE GREEN BILE MEDIA

Similar experiments were performed with media containing malachite green in place of brilliant green. The results are recorded in table 4.

The results recorded in table 4 are very similar to those of table 3, except, in general, the malachite green media is a little more inhibitive to anaerobes than is brilliant green media. The cultures of B. welchii, Type II showed the same resistive power in the malachite green media as was shown with the other dyes.

GENERAL DISCUSSION

In general the dyes studied are effective in lactose broth in concentrations of 1:100,000 or greater. B. welchii, Type II, is, however, an exception. The dyes reported here, as well as crystal violet, require a dye dilution of 1:20,000 to prevent the growth of cultures belonging to this type.

The addition of bile to the lactose dye media produces media giving much different results with anaerobes. The growth was very much

TABLE 4

TABLE 4

Reciprocals of malachite green content required to prevent gas production in forty-eight hours

ORGANISM		BILE, PER CENT										
		1	2	3	4	5	6	7	9	11	13	15
Multifermentans	A	100,000	100,000	100,000	100,000	75,000	50,000	50,000	30,000	30,000	30,000	20,000
	B	100,000	100,000	100,000	100,000	50,000	35,000	35,000	25,000	25,000	25,000	15,000
Tertius	A	100,000	100,000	50,000	35,000	35,000	30,000	25,000	20,000	15,000	15,000	6,500
	B	100,000	100,000	75,000	50,000	35,000	35,000	30,000	15,000	15,000	15,000	6,500
Sphenoids	A	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
	B	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Welchii Type I	A	100,000	100,000	100,000	75,000	50,000	35,000	35,000	30,000	20,000	15,000	15,000
	B	100,000	100,000	100,000	100,000	100,000	75,000	35,000	35,000	25,000	20,000	20,000
Welchii Type II	A	1,000	1,000	1,000	1,000	1,000	1,000	1,000	>1,000	>1,000	>1,000	>1,000
	B	1,000	1,000	1,000	1,000	1,000	1,000	>1,000	>1,000	>1,000	>1,000	>1,000
	C	1,000	1,000	1,000	1,000	1,000	1,000	1,000	>1,000	>1,000	>1,000	>1,000
Welchii Type III	A	100,000	75,000	50,000	35,000	35,000	30,000	20,000	6,500	6,500	6,500	6,500
	B	100,000	100,000	100,000	100,000	100,000	100,000	100,000	75,000	50,000	50,000	35,000
	C	100,000	100,000	100,000	100,000	75,000	75,000	35,000	35,000	35,000	100,000	100,000
	D	100,000	100,000	100,000	75,000	75,000	35,000	35,000	25,000	15,000	15,000	15,000
Welchii Type IV	A	100,000	100,000	100,000	100,000	75,000	75,000	50,000	50,000	25,000	25,000	20,000
	B	100,000	100,000	100,000	100,000	100,000	35,000	25,000	15,000	15,000	10,000	6,500
	C	100,000	100,000	50,000	50,000	50,000	35,000	20,000	6,500	3,500	3,500	3,500
	D	100,000	100,000	100,000	100,000	75,000	75,000	50,000	30,000	15,000	15,000	10,000

accelerated. The bile seems to neutralize the inhibiting effects of the dyes. The contention of Hale that a dye content of 1:75,000 was not sufficient to inhibit the growth of anaerobes has been confirmed. However, 1:75,000 dye and 2 percent bile is nearly as effective as 1:20,000 dye and 5 percent bile. In the 5 percent bile-dye media a dye content of 1:20,000 or 1:25,000 was nearly as effective as a dye strength of 1:10,000. The aim of a medium for water analysis is to inhibit as many foreign forms of bacteria as possible and still permit the growth of the colon group unhampered. As far as anaerobes are concerned a bile content of 5 percent and a brilliant green dye content of 1:20,000 seems to give a satisfactory medium. In the case of malachite green, the dye content could be easily reduced to 1:30,000. It must be borne in mind, however, that a strong enough dye concentration to inhibit all anaerobes is not possible in a medium for water analysis. The cultures of B. welchii, Type II, were able to produce ample gas in a dye content of 1:1,000.

CONCLUSIONS

1. In general, a dye content of brilliant green or malachite green greater than 1:100,000 is ample to inhibit the growth of anaerobes in lactose broth.

2. B. welchii, Type II, is very resistant to the dyes in lactose broth. A dye concentration of at least 1:20,000 is required to prevent gas formation.

3. A dye concentration of 1:20,000 in case of brilliant green and 1:30,000 in case of malachite green, is sufficient in 5 percent bile medium to inhibit most anaerobes.

4. The inhibitive power of dyes in lactose broth decreases as the percentage of bile increases.

REFERENCES

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(2) POE, 1930. "Growth of anaerobes in crystal violet bile media." Jour. Bact., 19, 117.

(3) HALL AND ELLEFSON, 1918. "The elimination of spurious presumptive tests for B. coli in water by the use of gentian violet." Jour. Bact., 3, 329.

(4) HALL AND ELLEFSON, 1919. "Further studies on gentian violet as a means of eliminating spurious presumptive tests." Jour. Amer. Water Works Assoc., 6, 67.

(5) WAGNER AND MONFORT, 1921. "Lactose broth for isolating Bacterium coli from water." Amer. Jour. Pub. Health, 11, 203.

(6) DUNHAM, MCCRADY AND JORDAN, 1925. "Studies of differential media for detection of Bact. coli in water." Jour. Amer. Water Works Assoc., 14, 535.

(7) RUCHHOFT, 1926. "Comparative studies of standard methods and the brilliant green bile medium on Lake Michigan water at Chicago." Jour. Amer, Water Works Assoc., 16, 778.

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(9) DUNHAM AND SCHOENLEIN, 1926. "Brilliant green bile media." Stain Tech., 1, 129.

(10) JORDAN, 1927. "Brilliant green bile for the detection of the colon-aerogenes group." Jour. Amer. Water Works Assoc., 18, 337.

COMPARATIVE NATIONAL FIRE LOSSES[1]

The losses of Great Britain and Ireland, Canada, and the United States for a nine-year period are given below in parallel columns. For convenient comparison the losses of Great Britain and Ireland have been reduced to dollars. It is interesting to note that the upward trend in losses registered in 1929 is of an international character.

	GREAT BRITAIN AND IRELAND		CANADA		UNITED STATES	
	Total loss	Per capita	Total loss	Per capita	Total loss	Per capita
1921	$45,200,000	$1.02	$45,016,000	$5.22	$495,406,000	$4.56
1922	46,100,000	1.04	54,391,000	6.11	506,541,000	4.62
1923	63,250,000	1.43	48,571,000	5.36	535,373,000	4.84
1924	43,400,000	0.97	45,907,000	4.99	549,062,000	4.90
1925	43,800,000	0.99	40,730,000	4.35	559,419,000	4.85
1926	42,410,000	0.96	38,395,000	4.15	561,980,000	4.80
1927	38,361,000	0.87	32,254,000	3.29	472,933,000	3.96
1928	51,654,000	1.17	36,402,000	3.79	464,607,000	3.87
1929	75,901,000	1.72	47,232,000	4.82	473,574,000	3.92

[1] National Fire Protection Association, 24: 1, July, 1930, page 38.

ABSTRACTS OF WATER WORKS LITERATURE

FRANK HANNAN

Key: American Journal of Public Health, **12**: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Accidental Over-Chlorination of Water. ULSAMER. Z. Desinfektionswesen, **20**: 182–3, 1928; Wasser u. Abwasser, **25**: 175. From Chem. Abst., **23**: 2774, June 10, 1929. Melting snow may cause over-chlorination because of low organic content. Since slight excess of free chlorine in water readily unites with organic matter in stomach, no harm results. It is better to err on side of safety than to allow infected water to be used.—*R. E. Thompson.*

A Simple Apparatus for the Sterilization of Water by Caporit or by Chlorine. C. P. MOM. Waterstaats-Ing., No. 5, 1928; Wasser u. Abwasser, **25**: 44. From Chem. Abst., **23**: 2774, June 10, 1929. Use of either chlorine or Caporit for water purification in Dutch East Indies has given excellent results. Simple concrete dosing tank with guarded outlet described.—*R. E. Thompson.*

Combining the Zeolite Softener and Deconcentrator Gives Improved Boiler Water. LUCIUS A. FRITZE and ELWOOD W. SCARRIT. Power, **69**: 392–5, 1929; cf. C. A., **23**: 1973. From Chem. Abst., **23**: 2775, June 10, 1929. Use of zeolite alone increases alkalinity and concentration of sodium and potassium. Deconcentrator equipment is designed to mix zeolite softened water from boiler with raw water in suitable proportion to form sludge. After settling, clarified water is returned to boiler.—*R. E. Thompson.*

Softening of Water for Boiler Purposes. W. J. PITT. Chem. Eng. Mining Rev., **21**: 188–90, 1929. From Chem. Abst., **23**: 2775, June 10, 1929. Methods and formulas given for determining amounts of lime and soda ash required for softening boiler water.—*R. E. Thompson.*

Scale Formation in Hot and Cold Water. M. GROECK. Gesundh. Ing., **52**: 97–102, 1929. From Chem. Abst., **23**: 2775, June 10, 1929. Scale formation is dependent on disturbance of equilibrium between calcium carbonate and carbonic acid, on presence of oxygen, and on reactivity of metal present.—*R. E. Thompson.*

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[1]Vacancies on the abstracting staff occur from time to time. Members desirous of coöperating in this work are earnestly requested to communicate with the chief abstractor, Frank Hannan, 285 Willow Avenue, Toronto 8, Ontario, Canada.

Scale Formation in Central Heating Plants. W. BLEYERT. Gesundh. Ing., 52: 58–61, 1929. From Chem. Abst., 23: 2775, June 10, 1929. Boiler scale results in loss of heat as it conducts heat only $\frac{1}{28}$ as well as iron. Action of "Groeck boiler scale solvent" and that of hydrochloric acid have been compared. This solvent was found to be as effective as hydrochloric acid in removing scale and its corrosive action was much less.—*R. E. Thompson.*

A Practical Investigation of Corrosion for the Heating Industries. H. BALCKE. Gesundh. Ing., 52: 49–53, 1929. From Chem. Abst., 23: 2775, June 10, 1929. Older, or acid theory is incorporated in modern electrochemical theory of corrosion. According to this theory, metal goes into solution in form of ions by virtue of its solution pressure. Presence of acid merely increases rate of solution. Iron goes into solution in form of ferrous ions, which are oxidized to insoluble ferric iron by oxygen. Hence oxygen is important factor. Temporary hardness of boiler-feed water is rapidly precipitated under influence of heat. Mineral acid hardness concentrates in boiler and often causes much damage. Salt blamed more than any other is magnesium chloride. Claimed that magnesium chloride hydrolyzes, giving magnesium hydroxide and hydrochloric acid. Latter reacts with the iron, forming ferrous chloride. Hydrochloric acid is sometimes added to prevent carbonate scale. Such practice is to be discouraged because much magnesium chloride is formed as result.—*R. E. Thompson.*

The Hygiene of Bathing, Swimming Ponds and Waters. A. L. THOMSON. Munic. Eng. Sanit. Record, 82: 253, 1928; cf. C. A., 23: 1708. From Chem. Abst., 23: 2777, June 10, 1929. Pond, with capacity of 100,000 gallons, contained 500 bacteria per cc. when freshly filled, but, after use by 380 bathers, 342,000 per cc. Intelligent control of continuous purification plant will maintain pool in hygienic condition.—*R. E. Thompson.*

Sewage Pollution (of Stream) Punishable if Contrary to Legal Stipulations. J. GENNERICH. Mitt. Fischereiver. Prov. Brandenburg, No. 17, 395, 1928; Wasser u. Abwasser, 25: 178. From Chem. Abst., 23: 2777, June 10, 1929. Following bestowal of right for use of water from brook, industrial manufacturing plant discharged acid waste into streams thus destroying several hundred fish. Court held that this action constituted negligent transgression of Water Laws and imposed fine.—*R. E. Thompson.*

Tensile Test of Centrifugal Reënforced Concrete Pipe. YAJIRO NAGAYAMA and JUNKICHI KATO. Bull. Reconstruction Bureau (II), 10, 57–75, 1927. From Chem. Abst., 23: 2801, June 10, 1929. Seven samples were tested. Density and strength are greater than those of ordinary concrete pipe.—*R. E. Thompson.*

The Filtration of Water for Textile Purposes. S. R. TROTMAN. Dyer, Calico Printer, 61: 120–2, 1929. From Chem. Abst., 23: 2830, June 10, 1929. Methods of treating water are considered with regard to type of water and requirements of textile process concerned.—*R. E. Thompson.*

Tannery Waters. E. MEZEY. Collegium 1929, 55–68. From Chem. Abst., 23: 2846, June 10, 1929. Buffer action, measured by dA/dpH, where A is quantity of added acid or alkali, discussed briefly. Buffer curve is of value in determining suitability of water for tannery use.—*R. E. Thompson.*

Notes on the Detection of Aluminum by Dyestuff Reagents. EDWIN EEGRIWE. Z. anal. Chem., 76: 438–43, 1929. From Chem. Abst., 23: 2901, June 20, 1929. Of 4 dyestuffs tested, morin is most characteristic but is easily influenced by iron. Alizarin S is most sensitive to aluminum, but also to effect of iron. Alizarin red P S is sensitive and shows fluorescent as well as color effect. Eriochromocyanin R is sensitive and best of the four in presence of iron.—*R. E. Thompson.*

Determination of Small Quantities of Nitrate Nitrogen. B. G. ŠIMEK. Chem. Listy., 22: 353–7, 473–6, 1928. From Chem. Abst., 23: 2902, June 20, 1929. Reduction methods of DEVARDA and of ULSCH are unsuitable for determination of small quantities of nitrate nitrogen (less than 2 milligrams), while that of ARND gives average error of only about 1 per cent when duraluminum is used for reduction. GLADSTONE-TRIBE colorimetric method gives results on average 10 per cent below actual values. MARX-TROMMSDORFF titration method gives good agreement for quantities of nitrogen within limits 0.1–0.5 mgm.; method cannot, however, be applied in presence of sodium chloride.—*R. E. Thompson.*

A New Method for Testing the Porosity of Anti-Corrosion Coatings. J. COURNOT. Rev. métal., 26: 76–7, 1929. From Chem. Abst., 23: 2922, June 20, 1929. Filter paper is moistened with solution of potassium ferricyanide and alkali chloride and applied immediately to surface to be tested. Defects in coating produce stains on paper, color depending on nature of metal to which coating was applied. By washing out the ferricyanide and drying the paper, permanent record of test is obtained.—*R. E. Thompson.*

Increasing the Resistance to Corrosion by Means of Protective Coatings. E. REMY. Gesundh. Ing., 52: 234–6, 1929. From Chem. Abst., 23: 2922, June 20, 1929. Protective coating "Gabrit" is applied in solution and protective film is formed on drying. It protects against attack in acid, salt, and alkaline solutions. It was proved that protection is obtained in water and active chlorine preparations. However, if an imperfect film is obtained, immediate corrosion results.—*R. E. Thompson.*

The Stratification of Oxygen in Lakes. L. L. ROSSOLIMO. Arch. Hydrobiol., 19: 731–41, 1928. From Chem. Abst., 23: 3036, June 20, 1929.—*R. E. Thompson.*

Tryptophan-Peptone Solution Prepared from Casein as Medium for Fecal Coli Bacteria at 45–46°. T. FOLPMERS. Nederland. Tijdschr. Hyg. Microbiol. Serol., 3: 281–4, 1929. From Chem. Abst., 23: 3001, June 20, 1929. Detailed description of method given in original. After 6 hours it shows indole reaction. Author has used medium daily for over year in conjunction with EYK-

MAN test for river water, while for drinking water MACCONKEY test is added with lactose as sugar. Neither aërogenes nor cloacae influences reaction. Advisable to apply the above-mentioned 3 tests at same time. Positive results indicate amount of fecal coli in sample. Sugars, and also mannitol, added in low concentrations to tryptophan solution, prevent formation of indole.—*R. E. Thompson.*

Proof of Water Pollution by a Simple Method. CH. GAUSSEN. Zentr. ges. Hyg., **18**: 394, 1928; Wasser u. Abwasser, **25**: 213; cf. C.A., **22**: 3007. From Chem. Abst., **23**: 3041, June 20, 1929. On basis of observation that most pathogenic bacteria to be found in water not only form indole from peptone solutions, but also decolorize toluidine blue, author uses this combination of tests to detect pollution of water.—*R. E. Thompson.*

The Graphical Representation of the Chemical Constituents of Mineral Waters. Z. DALMADY. Z. ges. physik. Therap., **34**: 144–7, 1927; Wasser u. Abwasser, **25**: 101. From Chem. Abst., **23**: 3035, June 20, 1929. Anions and cations are graphically located on circular diagram to show at glance their true relationships.—*R. E. Thompson.*

The Determination of Sulfate in Natural Waters and in Soil Extracts. B. SAPROMETOV. Bull. Univ. Asie Centrale; Wasser u. Abwasser, **25**: 40, 1928. From Chem. Abst., **23**: 3036, June 20, 1929. Comparison was made of gravimetric method as barium sulfate, the benzidine method, and the titrimetric iodine methods. For routine work sufficient accuracy was obtained with modified rapid benzidine method of RASCHIG (cf. C.A., **21**; 3242) to recommend it.—*R. E. Thompson.*

A Rapid Method for Estimation of the Total Hardness by the Separate Estimation of the Lime and Magnesia Hardness. KURT V. LUCK and HANS J. MEYER. Z. angew. Chem., **41**; 1281–4, 1928. From Chem. Abst., **23**; 3037, June 20, 1929. After testing method of BERG (cf. C.A., **21**; 2449) a rapid method for separate determination of calcium and magnesium hardness is outlined as follows: Precipitate calcium as oxalate and titrate with N/28 potassium permanganate. To cooled filtrate carefully add 2 cc. 2 per cent alcoholic 8-hydroxyquinoline on surface of filtrate. After 5 minutes heat the solution to boiling. If yellow color disappears, add more of solution until liquid is definitely colored yellow. After boiling short time, allow to cool and stand for about 1 hour. Filter the precipitate and wash beaker with 2.5 per cent ammonia water. After washing 3 times on filter with ammonia water, dissolve in 8–10 per cent hydrochloric acid in original beaker. Add 2–3 drops aqueous indigo-carmine solution to the hydrochloric acid solution in stoppered Erlenmeyer flask. Titrate blue liquid with bromate-bromide solution (N–14) to yellow color. Add 2 to 3 cc. 20 per cent potassium iodide solution and, using starch as indicator, titrate excess bromate solution with N/140 thiosulfate. If 50 cc. water is used, number of cc. bromate-bromide solution gives magnesium hardness. Satisfactory results are obtained by this method; 6 such determinations can be made in 1.5 hours.—*R. E. Thompson.*

Dependence of Oxidizability on the Fluctuations of the Ground Water Level. BR. PUCHOWSKI. Zentr. ges. Hyg. Grenzg., 17: 801, 1928; Wasser u. Abwasser, 25: 113. From Chem. Abst., 23: 3036, June 20, 1929. No corrrelation could be observed in 4 wells between oxidizability of water and the level in the wells.—*R. E. Thompson.*

Deep Sand Rapid Filters. A. GRAUMANN. Pumpen u. Brunnenbau Bohrtechnik 1928, 397–9; Wasser u. Abwasser, 25: 127. From Chem. Abst., 23: 3037, June 20, 1929. Operation and cleaning of "Bollmann-Schnellfilter" described.—*R. E. Thompson.*

The Possibilities of Clenzal in the Purification of Water in Country Homes. ALFREDO PIO DE RODA. J. Philippine Is. Med. Assoc., 9: 1–4, 1929. From Chem. Abst., 23: 3036, June 20, 1929. Clenzal is uniformly effective in reducing bacterial count and in killing *B. coli* in water artificially inoculated therewith.—*R. E. Thompson.*

The History of the Chlorination of Drinking Water. SPITTA. Reichs-Gesundheitblatt, 33: 533–5, 1928; Wasser u. Abwasser, 25: 120. From Chem. Abst., 23: 3037, June 20, 1929. Critical review of development of chlorination in Germany for past 35 years.—*R. E. Thompson.*

A New Formula of the Reagent for the Detection of Nitrites in Water. STÉPHANE VERGNOUX. Bull. sci. pharmacol., 36: 146–7, 1929. From Chem. Abst., 23: 3037, June 20, 1929. Dissolve 2 grams neutral red in 18 cc. water, filter, cool and add 80 grams sulfuric acid. Use 100–150 cc. of water to be tested, and add 5 drops reagent. After stirring, a blue color appears if more than 1 milligram of nitrite nitrogen is present.—*R. E. Thompson.*

The Iodine Content of Tap Waters in Goitrous Districts. G. H. BECKWITH. Zentr. ges. Hyg., 17: 878, 1928: Wasser u. Abwasser, 25: 113; cf. C.A., 22: 2629. From Chem. Abst., 23: 3037, June 20, 1929. Iodine content of number of water supplies from goitrous districts in United States was determined. Following amounts (parts per billion) were found: Chicago 0.13; Litchfield, Ill., 0.17; Peru, Ill., hard ground water 0.31; Peoria, Ill., deep well, 0.15; LaSalle, Ill., deep well, 18.00; East St. Louis, Mississippi River, 0.29; Springfield, Ill., 50–52; Duluth, Minn., 0.014; Grantsville, Utah, 1.33.—*R. E. Thompson.*

Condensate as Boiler Feed. C. N. RIDLEY. Eng. and Boiler House Rev., 42: 406, 408, 1929. From Chem. Abst., 23: 3527, July 20, 1929.—*R. E. Thompson.*

Waste-Disposal—A Description of the Pennsylvania Study. E. G. BOYER. Am. Gas. Assoc. Monthly, 11: 201–4, 1929. From Chem. Abst., 23: 3042, June 20, 1929. Report of extension of "Pennsylvania Plan" of waste disposal by Pennsylvania Gas Association in coöperation with Pennsylvania Sanitary Water Board to include effluents from gas plants.—*R. E. Thompson.*

Recovery of Phenol from the Wash Water of Coking Plants. PAUL HOENING. Z. angew. Chem., **42**: 325–31, 1929. From Chem. Abst., **23**: 3071, June 20, 1929. Compelled to remove phenol from wash water because it created nuisance in rivers into which it was discharged, coking plants in Ruhr district will soon be adding 5000–6000 tons of this material per year to Germany's present production of 11,000 tons. Pyridine will also be recovered in quantity. Wash water contains only 2–3 grams per liter, and discharge into rivers must not contain more than 0.6–0.8 gram per liter. POTT-HILGENSTOCK process is used, viz., extraction of wash waters with immiscible solvent like benzene or its homologs, separation of the aqueous and phenol-containing layers by gravity, and recovery of phenol by distillation of this solution or by treatment with alkali. Treatment with alkali proves to be preferable to distillation, both because of cost and quality of product. It is calculated that 100 kilograms of phenol recovered by distillation costs 28.07 M., and by alkali process, 17.67 M. In Ruhr district alone more than 30,000 tons of phenol is available annually.—*R. E. Thompson.*

Disposal of Ammonia Liquors. D. W. PARKES. J. Soc. Chem. Ind., **48**: 81–6T, 1929; cf. C.A., **21**: 2549, 3449. From Chem. Abst., **23**: 3327, July 10, 1929. Cost of purification of virgin or spent ammonia liquors is balanced and profit may be realized by recovery of phenol and catechol. Monohydroxy phenols are recovered by process of acidification, absorption in active charcoal and steam distillation. The ammonia liquor is adjusted to pH 6–7 with mineral acid or almost to neutrality with carbon dioxide, settled and passed through active charcoal. When several absorbers are used in series, the first becomes saturated before others and may be cut out for distillation while reserve is put in at end of series. In general, 3 absorbers containing 50 pounds of carbon each will care for 200 gallons of liquor per hour, one absorber being distilled every 5 hours. During distillation, 3 fractions are obtained: (1) everything until distillate separates into 2 layers (350°); (2) tar acids (up to 650°); and (3) 650–800°. During fraction (2) water ceases to come over (500°) so steam is admitted; (1) and (3) are returned to absorbers. Dihydroxy phenols should be removed before monohydroxy phenols in handling low temperature and vertical retort liquors. Liquor is brought to pH 5–6 by means of mineral acid to precipitate organic matter, which would cause waste, and to remove sulfides and carbonates. In some cases distillation is sufficient pretreatment; in others it is necessary to add calcium hypochlorite and lime. After decantation, $C_6H_4O_2Pb$ is precipitated at pH 8 (by addition of ammonium hydroxide) by solution containing 46.05 per cent lead chloride, 38.37 per cent sodium acetate, 14.8 per cent water and 0.78 per cent nitric acid (density 1.4). Lead precipitate is treated with concentrated hydrochloric acid, filtered, steam distilled and evaporated to give crystals of dihydroxy phenols.—*R. E. Thompson.*

Further Results from Plants for Phenol Recovery from Ammonia Liquors. H. WIEGMANN. Glückauf, **64**: 605–6, 1928. From Chem. Abst., **23**: 3327, July 10, 1929. From liquor were isolated 52 per cent phenol, 9 per cent *o*-cresol, 16 per cent mixed cresols, 7.5 per cent mixture of cresols and xylenols.

Inadequate washing removes only about 25 per cent of phenol, but about 75 per cent of cresol. In another plant with better washing, these figures were 50 and 80 per cent. Steam requirements, at first very great, can be reduced considerably, particularly through heat exchangers. If washing apparatus works well, 25 per cent benzene, calculated on amount of wash liquor, suffices to give satisfactory phenol removal. Only large scale working can decide as to respective merits of benzene and alkali extraction methods. First process has advantages that it is very simple to work and does not require any additional chemical.—*R. E. Thompson.*

Apparatus and Method for the Rapid Determination of "Available Chlorine" in Weak Hypochlorite Liquor. J. M. TAYLOR. Ind. Chemist, 5: 135–6, 1929. From Chem. Abst., 23: 3182, July 10, 1929. If solution of hypochlorite is mixed with excess hydrogen peroxide, 1 molecule of oxygen is evolved for each molecule of hypochlorite. Apparatus is shown and described which measures gas pressure produced by this reaction and which is suitable for use in bleaching plant. The available chlorine-pressure relationship is shown in table.—*R. E. Thompson.*

Passivity of Metals and Its Relation to Problems of Corrosion. ULICK R. EVANS. American Institute Mining Met. Eng., Tech. Publ. No. 205: 23 pp., 1929. From Chem. Abst., 23: 3199, July 10, 1929. Passivity of metals is due to protective film which is product of direct reaction of metal with oxygen. Film is insoluble in concentrated nitric acid at ordinary temperatures and is therefore believed to be ferric oxide. Function of oxygen in aqueous corrosion is to divert attack to regions of lower oxygen concentration. Rust is not direct reaction product but is precipitate formed by secondary reactions. Rusting takes place at points where there is break in film which is the direct reaction product.—*R. E. Thompson.*

Observations on the Corrosion of Iron. J. F. G. HICKS. J. Phys. Chem., 33: 780–90, 1929. From Chem. Abst., 23: 3199, July 10, 1929. Corrosion of iron is attributed to solution of iron in water as primary cause. Film of water adhering to metal surface undergoing corrosion is necessary to this dissolving process. Oxygen produces maximum e.m.f. with respect to dissolving iron and acts as accelerator; it removes ferrous hydroxide and hydrogen by oxidation and is hence a maintenance factor in corrosion process. Carbon dioxide is also maintenance factor, because of removal of ferrous hydroxide, and it accelerates reaction by decreasing pH.—*R. E. Thompson.*

The Development of Water Supply after the War. E. GROSZ. Z. f. Kommunalwirtschaft, 19: 8, 460, 1929. After the war, water works in Germany suffered from lack of material, strikes, and depreciation of money value. Building was almost impossible though Wiesbaden rebuilt its water-works by using unemployed labour. After the stabilisation of the mark, other cities, for example Hamburg, proceeded with building and extension work. The removal of water works from state control to companies has been a great incentive to progress and economy. Taking into account the general depre-

ciation of money values, water in most towns is cheaper than before the war. Works built after the period of inflation, however, are in a different condition and prices are often very high. Many towns endeavoured to raise the standard of their water after the war and ground water was largely substituted for river water. So-called "ground river water," i.e., water from wells sunk in the valley of a river and gathering the naturally filtered river water, has been used. At Wiesbaden this proved unsatisfactory and had to be treated with chlorine and ozone, and a supply of artificial ground water, water drawn from the river and treated, has been substituted. Several epidemics of typhoid broke out and, though they were mainly due to fortuitous combinations of unfavourable circumstances, they led to more careful considerations of water works conditions. Treatment with chlorine has increased since the war. Slow sand filtration has been largely abandoned, rapid filtration with subsequent chlorination being substituted. Water softening is also more practised than formerly, especially owing to the growth in the use of high pressure boilers. Corrosion and incrustation of pipes have been investigated and the best means of prevention found in treatment of the water. Piston pumps are being largely replaced by rotary pumps.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board*).

Technical Progress in Water Works Management. VOLLMAR. Z. f. Kommunalwirtschaft, **19**: 8, 467, 1929. The article gives examples of progress in water works management since the war. The great aim is to replace small water works with great central supplies for larger areas. Such systems are being prepared in Middle Saxony and for supplies from the South and East Harz valley dams, which serve the purpose of the English storage reservoirs in supplying a very greatly increased summer need. It is also intended to use surface waters to increase and enrich ground water supplies. In water preparation, rapid filtration is quickly superseding slow sand process. Treatment with lime water for de-acidification and with chlorine for bacteriological purification have increased largely. Control of working by a works laboratory, which in the case of small works could be used in conjunction with neighbouring works, is important. Electric working of pumps either fully or partly automatically controlled is being more and more adopted. The general type of valve is the wedge-shaped, but under special circumstances ball valves are being applied. These in some cases include in their casings instruments for measuring and recording the flow. Lately ferroconcrete pipes have come largely into use. These consist of a thin sheet metal jacket reinforced inside and outside with ferroconcrete. Deacidifying of the water is especially important when such pipes are used. In main pipe lines special devices against flooding, with automatic or semi-automatic mechanism, are installed. Emergency repair services for night work or times of frost are essential. Movable indicators are used for showing defects, a simple type being the geophone, a highly sensitive drum with weight-stretched membrane. For the welfare of the workers it is advisable for large works to procure the services of a safety engineer.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board*).

Water Filtration Plant at Picton, Ontario. W. TAIT. Canad. Eng., **56**: 465, 1929. Waterworks consisting of a steam pumping plant were established on the bay of Quinte, at Picton, Ontario, in 1887. In 1929 the pumping station was changed over to electrically driven units. A new pumping station has now been erected 1,400 feet below the old one, on land jutting out into the bay of Quinte, where intake conditions are better. The plant consists of intake pipe, suction well, double screens, four pumps, two horizontal pressure filters, four alum solution tanks, a Wallace Tiernan M.S.P.M. chlorinator, and a Venturi meter register. The intake pipe extends 1000 feet out into the bay and its inlet end is 20 feet below high water mark. The suction well is 5 feet wide and 24 feet long. Pumps include one new 600-g.p.m. spare pump driven by petrol engine; two electric pumps from old station, with combined capacity of 600 g.p.m., and one new 350-g.p.m. electrically driven pump. The filters are 8 feet by 20 feet and the filter bed consists of 15 inches of Cape May gravel in four sizes. The chlorinator has a capacity of 10 pounds of chlorine per 24 hours. The constructional details of all parts of the plant are noted. Two plans of the building are given, one showing the position of filters and pumps, the other, the piping arrangement. Two sections of the building show the connections between the different parts of the plant.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board*).

Some Modern Methods of Removing Bacteria, Manganese, and Acids from Drinking and Industrial Water. W. OLSZEWSKI. "Vom Wasser." Ver. Deutscher Chemiker, Berlin, **1**: 15, 1927. A description of the methods generally employed for the removal of bacteria, manganese salts, and acidity from water supplies, with special reference to conditions in Dresden. Chlorination is generally adopted for disinfection, with special control of the amount of the phenol content of the water. Objections to its use in swimming baths have been met in several ways, of which the monochloramine method appears promising. Manganese salts are generally removed by the action of different iron-bacteria, of which a form differing from the usual filamentous type has been described by CHOLODNY. A short account is given of the electro-chemical theory of corrosion and of the effects of neutralising acids by lime water.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board*).

Examination of Swimming Pools. H. ILZHOFER. Gesund. Ing., **51**: 32, 513, 1928. In 1926 the two filter plants for the Munich public baths were replaced by one, for which the same chlorinating plant served. Experiments and observations were carried out on the condition of the water and the effect of filtration and chlorination. *Condition of the Water.* Chlorinating removed the smell which, though the water itself appeared odourless after 14 days retention, had been previously noticed in the building. KISSKALT's method for estimating turbidity gave satisfactory conditions of clarity after 14 days retention period. The pollution of the bath by bathers is discussed and details of different analyses before and after use are given. Chloride content generally varied, nitrates increased more or less substantially, dissolved or-

ganic matter seemed to show little change, though, when estimated by its chlorine combining power, it rose definitely. Comparative analysis in the case of the Munich baths was difficult, for the water is drawn in varying proportions from two differing sources. Chemical and physical measurements of turbidity are more useful in estimating purity than chemial analysis of dissolved matter; but the latter, especially in the case of nitrogen-containing matter, should not be neglected. Chemical condition corresponds to a large extent with appearance, but this is never the case with bacterial condition. In the first two or three days after a new filling, the germ-count grows while the water remains clear; then it sinks and remains low while the water becomes more turbid and deteriorates chemically. The germ count therefore does not serve as a measure of impurity but is useful to test the working of filtration and chlorination. The danger of infection by pool water is very slight and is to be judged, not by germ-count, but by estimation of coli-titer. A knowledge of the health conditions of the city is necessary in estimating the possibility of danger. *Effect of filtration.* A Bamag filter, 870 mm. deep, with graduated filling, varying from 20–30 mm. to 0.1–1 mm., is used. The bath is refilled every 14 days and has a daily fresh water addition of 5 percent of its content. Filtration was found to remove 71 percent of suspended, 74 percent organic and 50 percent inorganic matter. Experiments showed that a rapid flow-through had no effect on bacterial count, while very slow flow caused turbidity in the pool; a flow of 75 cubic meters per hour, or 3.4 cubic meters per square meter of filter area per hour was therefore chosen, whereby the germ count was decreased 50 percent. *Effect of Chlorination.* The Bamag direct process is used. The chlorinated water enters the pool continuously through numerous small holes in a pipe across the width of the pool floor. By a comparison of chlorine additions in various baths, LEMMEL found that the amount required rose almost proportionately to the number of bathers. To remove danger of infection in the pool itself requires chlorine excess of 0.3 to 0.5 mgm. per litre, which is unpleasant to bathers and, by dissolving out organic matter from the filter, renders the water turbid. Hamburg meets the difficulty by a large dose of chlorine and then coagulating with aluminium sulphate before filtration; but this must cost considerably more than simple filtration. LEMMEL and OLSZEWSKI demand in the swimming pool water an excess detectable by benzidin, but not by zinc-iodide-starch reaction. This amount, however, affects filter working and leads to turbidity. When this excess was detectable in the flow-off, the author found chlorine smell over the filter and sometimes in the pool hall and some turbidity towards the end of the 14 days filling period. Bacterial count decreased, but as this is not a criterion of purity and as *B. coli* were as effectively removed by a lower chlorine dose, the chlorination used by Munich is only enough to give a definite excess in the entering water (0.35 to 0.4 mgm. per litre), but not to be constantly positive to benzidin reaction at the flow-off. References to literature on the subject are given.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board*).

Water in the Manufacture of Ice. W. STEFFENS, Z. angew. Chem., **42**: 22, 625, 1929. Chem. Ztg., **53**: 46, 451, 1929. Bicarbonates of calcium and mag-

nesium and compounds of iron and manganese are specially undesirable in waters to be used for ice manufacture. A high content of free carbonic acid causes turbidity. Hardness over 4.0° must be removed and content of iron and manganese must be less than 0.2 mgm. per litre. The free carbonic acid may either be brought into combination in the purification process or else removed by blowing air through during freezing. This process also prevents the salts which cannot be removed by chemical preparation processes from collecting and forming turbidity in the last frozen part of the water. By this method water containing 170 mgm. per litre of easily soluble salts can give good quality ice and under specially good working conditions water with 340 mgm. per litre and even more can be used.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board*).

Experience in the Working of an Experimental Plant of the Stuttgart Waterworks for the Treatment of Surface Water containing Humin. ENGLER, Z. angew. Chem., **42**: 22, 623, 1929. Objections were raised to the addition to Stuttgart's water supply of water from the Schwarzwald (Black Forest), which is very soft, contains on an average 6.9 mgm. per litre of marble-dissolving carbonic acid, and has a varying degree of colour due to drainage into it from a moorland district. The humin was easily removed on a laboratory scale, but experiments in a small rapid filtration plant were considered necessary. Over 100 experiments under varying conditions were conducted. For precipitation aluminium sulphate (10 to 60 gm. per cubic meter) and calcium hydroxide (2.7 to 6.2 gm. per cubic meter) were used. Filtration speed varied between 80 and 300 meters per 24 hours and settling time between 0 and 6 hours. The efficiency of purification was measured by diminution in colour and decrease in potassium permanganate demand. Addition of 20 gm. of aluminium sulphate and 5.4 gm. calcium hydroxide per cubic meter, with a filter speed of 170 meters and a raw water colour of 34 mgm/litre platinum, gave good results. It was found best to lead the water direct to the filter without settling, though the filter out-put was thus lessened. Experiments were made with LÜHPIG process with manganese sand with good results, but the regeneration of the filter necessitated extensions and the output was low. Mechanical and chemical methods of de-acidifying were tried and no difficulties were experienced. The experiments showed that it is possible by simple means to prepare from water containing humin a clear, colourless water, without objectionable taste, against which, because of its favourable place of origin, no hygienic objections can be raised.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board, Summary of Current Literature*).

New Methods for Softening Water and Removing Salts. O. GERTH. Z. f. Kommunalwirtschaft, **19**: 8, 484, 1929. An electric method (for softening and purifying water) devised by B. SCHWERIN and developed by the Electro-Osmosis Company, is described. The water flows through an apparatus consisting of 10 cells separated by insulating walls. Each cell is divided by diaphragms into three sections of which the outer two contain electrodes. The raw water flows into the middle section, is deprived of part of its salt by the

current between the electrodes, is syphoned to the middle section of the next cell, where more salts are lost, and so on to the tenth cell which it leaves entirely free from salts. The electrode-chambers have to be freed, by rinsing, from excess salt. The physical-chemical mechanism is described as follows. The dissociated dissolved salts and microscopic suspended matter are charged by the current and make their way, according to their charge, through the membranes to the cathode or anode where they give up their charge, or to the membranes where they adhere. The membranes are impermeable to water. With raw water with a very high salt-content, it is advisable to use first a chemical purification, such as Permutit filtration, as this saves current and increases the efficiency of the process. With water containing much carbonate, the rinsing water from the cathode chambers, which has given up some impurity there, is allowed to stand in settling chambers and is then returned to the middle cells of the system, leaving the system as distilled water. The process is automatic and the supply of water is cut off automatically if the current is broken. Direct current is necessary. The process can be used for complete removal of salts or for their removal to any required degree.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board*).

Water Softening Plant for the Largest Boiler in the World. K. TAUSSIG. Arch. f. Warmewirtsch. u. Dampfkesselwesen, **1928**: 96; Wass. u. Abwass., **24**: 270, 1928. The Beacon Street steam generating plant is the newest of four plants, which provide the industrial quarter of Detroit with steam. When completed it will have 12 boilers, each with a heating surface of 3855 square meters, and a generating capacity of 184.2 tons of steam per hour. The town water supply, with a hardness of 5.3°, is used as raw water. The Permutit softening plant consists of a large container, 3.05 meters in diameter and 7.6 meters long, with the usual apparatus for washing and regeneration and a layer of zeolite material of 1.05 meters high. The filter has an average capacity of 240 and a maximum capacity of 281 cubic meters per hour. Two softeners have already been built six will be needed in the completed plant. Sulphuric acid, 35 gms. per cubic meter, is added to the softened water, to maintain the proportion 1:1 between sodium sulphate and total alkalinity. The filtered water is boiled to free it from carbon dioxide and oxygen and then passed to the feed pump.—*M. H. Coblentz* (*Courtesy of the Department of Scientific and Industrial Research, Water Pollution Research Board*).

Sterilization of Water in Contact with Metal Circuits. G. LAKHOVSKY. Compt. Rend. Acad. Sci., **188**: 1069–71, 1929. From Bull. Hyg., **4**: 11, 937, November, 1929. Experiments were made to test theory that cell nucleus may be considered an electric oscillator of high frequency: a metallic contact alters oscillation period and kills the organism. Based on this theory, sterilizing action of a metal is physical. Cultures of *B. coli* or typhoid bacteria were placed in water in which were also immersed circuits of silver or other unozidizable metal. *B. coli* were killed in 25 hours and typhoid bacteria in a longer time. The dead organisms are said to exert an inhibiting action when more culture is introduced.—*Arthur P. Miller.*

Appreciation of Ground Waters containing Iron. L. MINDER. Schweiz. Med. Woch., 1929: May 25, 548–50. From Bull. Hyg., 4: 11, 937, November, 1929. Water contained in a stratum overlain by impermeable beds is likely to carry iron in solution which can be removed by aëration. The following analytical comparison of normal ground water and ground water containing iron is given:

CONSTITUENT	GROUND WATER	
	Normal	Containing iron
Iron	Generally < 0.3 p.p.m.	1 p.p.m. or more
Ammonia	Generally absent	Much
Nitrate	Variable, but always present	Absent, or, at most, traces
Sulphate	Always present	Possibly absent. H_2S
Oxygen	Absent, or only traces, at deep levels	Always absent
Bacterial quality	Good at deep levels	Good

A chemical explanation of these differences is given, supported by an experiment in which ferric oxide was exposed to sewage-polluted water in stoppered bottles in the dark. The resultant phenomena were in strict agreement with author's theory. Bacterial quality of underground water is good, despite low state of oxidation of nitrogen and sulphur. Chemical analysis, therefore, in such cases is not an altogether reliable guide to quality of water.—*Arthur P. Miller.*

Purification of Water containing Humus by Slow Sand Filtration. C. P. MOM and K. HOLWERDA. Meded. Dienst d. Volksgezondheid in Nederl.-Indie., 17: 561–8, 1928. From Bull. Hyg., 4: 11, 939, November, 1929. In 1927 Benkoelen was receiving water from lake made by damming up swampy valley. Floating masses of roots, earth, and humus were abundant and water contained much humic acid and iron. Bacteriological results of slow filtration through ferruginous sand were not good and filters rapidly choked, due to filming by compounds of iron and humic acid. Coagulation with alum at pH 4.8 to 5.3 gave clear effluent. Chlorination was not satisfactory owing to tastes and super-chlorination with subsequent dechlorination was too complicated. No simple chemical treatment appeared to be satisfactory.—*Arthur P. Miller.*

The Bunau-Varilla System of Water Purification. T. H. BISHOP. Lancet, 1929: February 16, 371–3. From Bull. Hyg., 4: 11, 939, November, 1929. Eau de Javelle, a solution of sodium chloride and hypochlorite, is siphoned from a container into the water supply. Calibrated constrictions in siphon tube control rate of flow. Siphon is automatically started when water is turned on in main.—*Arthur P. Miller.*

Floods and the Danger of Infection. H. KATHE. Klin. Woch., 8: 1134–7, 1929. From Bull. Hyg., 4: 11, 956, November, 1929. In 1737 an epidemic occurred in Breslau which was regarded as due to floods in 1736. No definite diagnosis was made, but it was called "mud-fever." Several similar epidemics have occurred in low lying parts of Germany and are sometimes called "water diseases." In 1926 and 1927 onset of the disease was sudden. Spirochaetes of the icterus type were found in blood cultures and in large numbers in the kidneys. Infection is believed to have come from overflowing of canals and rural ponds, polluting the water supply. It appears that a certain alkalinity as well as an increase in water temperature is needed for development of the spirochaetes. The appearance of these outbreaks only about every ten years is attributed to each generation becoming immune and to variations in virulence of the spirochaetes. As preventive measures, more attention should be given to the protection of water supply sources. After floods, proper care should be given to their disinfection.—*Arthur P. Miller.*

Report of the Water Pollution Research Board (England) for the year 1927–8. Dept. Scient. & Indus. Res., 1928. From Bull. Hyg., 4: 10, 815, October, 1929. Report covers year ending June 30, 1928, and includes report of Water Pollution Research Board, as well as report of the Director of Water Pollution Research. The Board's report touches upon the survey of the river Tees and upon their research program. In the director's report, considerable detail is given on investigation of treatment of beet sugar factory effluent at Colwick Experimental Station. Settling tanks, of 3½ hours capacity, reduce suspended solids 97.1 per cent. Tank liquor was then filtered at rate of 100 gallons per cubic yard per day through four different filter media. First seeding of filters had no appreciable effect as regards maturing them. After filtration, effluents passed through a humus tank. The contact time in the four filters at the rate used varied from 65 to 81 minutes. Laboratory experiments showed that a contact of not less than four hours would be necessary in order to attain the general standards of the Royal Commission on Sewage Disposal. Finer grade filtering material will be tried in two of the filters.—*Arthur P. Miller.*

The Pollution and Purification of Rivers with Special Reference to Domestic Sewage. Scottish Board of Health, Ninth Ann. Rep., 1927. From Bull. Hyg., 4: 10, 815, October, 1929. In a reprint from the Ninth Annual Report of the Scottish Board of Health, 1927, reference is made to the fact that with present scientific knowledge, it is not financially practicable to purify some trade wastes to the desired degree. The main sources of pollution in Scotland total 880, of which 538 are domestic sewage. The history of river pollution is touched upon and methods of sewage treatment and of treatment of beet sugar effluent explained. Pollution of tidal waters, BOYCE's investigations of the Severn, and a sewage fungus are cited. The conclusions of the 1898 Sewage Commission are summarized.—*Arthur P. Miller.*

Paths of Dissemination of Epidemic Poliomyelitis. W. WERNSTEDT. Acta Med. Scandinavica, 70: 565–72, 1929. From Bull. Hyg., 4: 10, 851, October,

1929. The generally accepted view at present is that epidemic poliomyelitis is spread by direct contact. Recently, however, some authorities have indicated that the virus may be spread by water. KLING maintains this view because of the greater frequency with which the virus is found in the intestinal mucosa than in those of the mouth and throat, and further because of a certain topographical peculiarity of poliomyelitis epidemics. In outbreaks in Sweden, Roumania, and Saxony the foci showed a special predilection for water courses.—*Arthur P. Miller.*

State Guards Water and Sewage Systems. H. C. FEIGHTNER. Monthly Bulletin, Indiana State Board of Health, 33: 4, 53, April, 1930. Complete control over water supply systems, both public and semi-public, sewerage systems and sewage disposal plants, stream pollution, swimming pools, bathing beaches, and tourist and other camps has been vested in the Indiana state board of health. Out of 146 samples taken from factory water supplies, 46 percent were found unfit for drinking purposes. It is estimated that nearly one-half the drinking water in Indiana is obtained from private wells, springs, and cisterns. Out of 1,228 samples tested from such sources, 69 percent were found unsatisfactory.—*G. C. Houser.*

Cross Connections in Gas Refrigerators. Monthly Bulletin, Ind. State Bd. of Health, 33: 4, 61, April, 1930. The weekly bulletin of the California Department of Public Health for April 5, 1930, calls attention to the fact that gas refrigerators are being installed with the cooling water connected directly to house sewers, forming a potentially dangerous cross connection between the sewer and the city water supply. These connections are being eliminated by requiring that the cooling water flow through the air into a collector attached to the sewer and having a water-sealed trap.—*G. C. Houser.*

Illinois Mobile Water and Sewage Laboratory. A. F. DAPPERT and H. F. FERGUSON. Illinois Health Quarterly, 2: 1, 36, January–March, 1930. A completely equipped mobile water and sewage laboratory was placed in service during the summer of 1929 by the Sanitary Engineering Division of the Illinois Department of Public Health. The cost, fully equipped, was only $5900. Among the analyses and tests that can be made in the mobile laboratory will be odor, color, turbidity, ammonia nitrogen, nitrite, nitrate, alkalinity, acidity, pH, chloride, chlorine, iron, dissolved oxygen, oxygen consumed, biochemical oxygen demand, bacterial count, *B. coli*, and microscopical examination.—*G. C. Houser.*

Sanitary Engineering. A. H. KEGEL. Chicago's Health, 24: 8, 42, February 25, 1930. In less than 40 years the typhoid fever death rate in Chicago has been reduced from 173.8 to 0.6 per 100,000. Protection against waterborne disease is effected through the following means: chemical and bacteriological tests of drinking water; prevention of dangerous contamination of Lake Michigan along lake front of city; coöperation with U. S. Public Health Service in supervising safety of water on vessels and trains; inspection of beaches and pools; elimination of dangerous cross-connections; supervision of

new plumbing installations; and inspection of the dumping of dredged materials into the lake.—*G. C. Houser.*

South Bend-Mishawaka Sewage Problem. Monthly Bulletin, Ind. State Bd. of Health, 33: 2, 24, February, 1930. In order to abate unhealthful conditions in St. Joseph River, the Indiana State Board of Health on February 17 called upon South Bend and Mishawaka to proceed to build intercepting sewers and sewage treatment plants without undue delay. In order to support this recommendation, report of a sanitary survey of St. Joseph River was submitted. The investigation had its inception in complaints alleging that the river entered Michigan from Indiana in such condition that it constituted a menace to public health, that fish life was interfered with, and that lawful uses of the stream were jeopardized.—*G. C. Houser.*

Two Water-Borne Epidemics. Monthly Bulletin, Ind. State Bd. of Health, 33: 2, 29, February, 1930. During December and January two outbreaks of dysentery occurred among the pupils of two schools in Cass County, Indiana. At the Washington Township School about 10 percent of pupils were affected. The second outbreak was at the Tipton Township School. In each case the epidemic was traced to a drilled well located in the school basement, the top of the casing of which was not sealed. Both basements were subject to flooding by septic tank effluent from floor drains. Following the epidemic, use of the wells was discontinued, and water was obtained from Logansport city supply.—*G. C. Houser.*

Wabash-White River Flood. Monthly Bulletin, Ind. State Bd. of Health, 33: 2, 30, February, 1930. From January 14 to 21, 1930, flood conditions prevailed in southern Indiana. At Vincennes, back water from Wabash River reached the filter plant, and sandbag dams were placed to protect the works. At Winslow, the low service pumps and the filter plant were flooded by Patoka River. To tide over the emergency, raw water was pumped into the system through a fire hydrant by a pumper, and the public was warned to boil the water. At Washington, the water works were threatened by flood water, but the activities of the local water company prevented any interruption of service.—*G. C. Houser.*

Court Decision Protects Village Water Supply. Health News (N. Y. State Dept. of Health), 7: 12, 45, March 24, 1930. An interesting judicial decision affecting the protection of public water supplies from pollution was recently rendered in suit instituted by village of Monroe against property owners on watershed of Lake Mombasha, from which the village water supply is taken. The court held that even if defendants had title to the narrow strip of land along the shore of the lake between the present water line and the line as it existed after the five-foot dam was originally finished, they would be entitled only to such riparian rights as might be enjoyed by the owner of lands under water to that extent. Such rights would include swimming, bathing, cutting ice upon defendants' own lands, watering cattle, and the like.—*G. C. Houser.*

Olean Still Engaged in Settlement of Typhoid Claims. Health News (N. Y. State Dept. of Health), 7: 13, 50, March 31, 1930. Common council of city of Olean, which has already expended $350,000 in payment of claims arising from water-borne typhoid epidemic in 1928, has recently requested permission of N. Y. State legislature to bond the city for an additional $75,000. In assuming complete liability for the epidemic, the city has held itself responsible for all medical and nursing care, and loss of time and life resulting from 212 cases with at least 18 deaths.—*G. C. Houser.*

How Big Is Your Town? Monthly Bulletin, Indiana State Board of Health, 33: 3, 46, March, 1930. Distribution of public water supplies in Indiana, according to population of towns in which they are supported, is given. Only 2 percent of all communities with population of 200–300 have public water supplies, whereas all communities with population over 2500 have supplies. Public water supplies are available to about 63 percent of the total state population, and to about 89 percent of those residing in communities having a population of 200 or more.—*G. C. Houser.*

Sanitary Water Board Progress. Pennsylvania's Health, 8: 2, 28, March–April, 1930. Despite the severe winter, stream survey work involving sources of pollution along the Schuylkill, Delaware, Allegheny, and Juniata Rivers was carried on without interruption. Much has already been accomplished on the Schuylkill River by the establishment of treatment plants. Considerable progress has been made by the major industries along the Juniata River in reducing objectionable characteristics of wastes discharged into it.—*G. C. Houser.*

On Certain Factors Influencing the Survival of Bacteria in Water and in Saline Solutions. E. N. BALLANTYNE. Jour. Bacter., 19: 303, 1930. Using laboratory stock solutions of various organisms in concentrations of 2 to 6 billion colony producers, definite conclusions were drawn in relation to their variability in water and saline solutions. Low temperature and high bacterial concentration were favorable factors for bacterial survival, but unfavorable for bacterial growth. Distilled water, particularly at room temperature rather than at 37°C., was shown to be a favorable medium for the survival of *B. typhosus*, *B. coli*, and others, this being due to a late period of low death rate, making possible a viable culture after 94 days. It is thought that this study may help to explain the occurrence of winter typhoid fever in temperate climates. An excellent bibliography is included.—*Edward S. Hopkins.*

Industrial Pollution of the Schuylkill River. Causes and Cures. LYLE L. JENNE. Ind. Eng. Chem., 22: 577–83, 1930. A very complete description of industrial pollution in the region between Norristown and Philadelphia is given. This includes wastes containing phenols, dyestuffs, and oils and those from the paper pulp, rag pulp, wool scouring, and slaughter house industries. Conditions in 27 plants located on the river are described. The author believes that industrial plant coöperation in the question of river pollution must be from the aspect of potential liability rather than from that of economic disposal.—*Edward S. Hopkins.*

Chemical Characteristics of the Hot Springs of Arkansas and Virginia. MARGARET D. FOSTER. Ind. Eng. Chem., 22: 632–3, 1930. Complete analyses of the waters of the hot springs of Virginia and Arkansas are given, together with a graphic chart. These waters are more or less uniform in composition with but slight changes from season to season, or from year to year. They are essentially calcium bi-carbonate waters.—*Edward S. Hopkins.*

Water Supply Problems Are Varied. ANON. Railway Age, 88: 23, 1379–1381, 1930. Abstracts of papers presented by J. P. HANLEY, E. M. GRIME, C. H. KOYL and R. E. COUGHLAN before the Illinois Section of the A. W. W. A. discuss requirements and improvements in Railroad water supply together with prevention of pitting and also sanitary control.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Treat Two and One-Half Million Gallons Per Day. R. E. COUGHLAN. Railway Engineering and Maintenance, 26: 5, 200–201, 1930. At the Proviso. Ill., terminal of the C. & N. W. RR., five wells approximately 1800 feet deep supply water varying in hardness from 12 to 35 grains per gallon. Water is softened to between 1 and 2 grains per gallons and 650,000-gallon storage is provided.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Uses Acid to Clean Well Screen. E. M. GRIME. Railway Engineering and Maintenance, 26: 4, 175–176, 1930. The original rate of flow, 500 gallons per minute from a 12-inch, 100 feet deep drilled well which had decreased 31 percent, on the Northern Pacific RR., at Jamestown, N. D., was fully restored by treating for 20 hours with 1,000 pounds commercial HCl.—*R. C. Bardwell (Courtesy Chem. Abst.).*

The Locomotive Water Conditioner. ANON. Railway Age, 88: 9, 567–568, 1930. New style of open type locomotive feed water heater is described, with diagram showing hot water compartments in front end of locomotive tender with necessary exhaust piping and automatic control.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Treating Plant Removes 430 Tons of Mud. C. M. BARDWELL. Railway Engineering and Maintenance, 26: 2, 65–67, 1930. Water softening plants were installed at Smithville and Forth Worth, Texas, by the M. K. & T. RR. to remove dissolved scale-forming matter varying from 7 to 17 grains per gallon and suspended matter as high as 440 grain per gallon. Lime and soda ash are used for softening, with sodium aluminate as a coagulant which is effective in removing color as well as turbidity. Control of chemical addition is handled by a turbine meter in the raw water discharges, which functions correctly with variable flow rate. Results have been very satisfactory.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Tests of the Martin Circulator. ANON. Railway Age, 88: 4, 255–256, 1930. Increased circulation equalized water temperature and reduced fuel consumption and also scale-formation and corrosion.—*R. C. Bardwell (Courtesty Chem. Abst.).*

Incrustation of Discharge Lines. E. M. GRIME and R. C. BARDWELL. Railway Engineering and Maintenance, **26**: 1, 29–31, 1930. Pipe line incrustation may result from either tuberculation, incomplete chemical reaction in treated water, or fluctuations in temperature. Recarbonation of softened water is not practical in railway service. Zeolite treatment, or coagulation with sodium aluminate is suggested.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Pitting Reduced by Feedwater Heater. C. H. KOYL. Railway Age, **87**: 23, 1329–30, 1929. Completion of comparative test on locomotives with and without open type feedwater heaters on the C. M. St. P. & P. RR., which was started in 1925, has demonstrated that corrosion of the tubes and sheets in locomotive boilers using waters containing large amounts of alkali salts, principally Na_2SO_4, can be very materially reduced by use of the open type heater which removed an average of 80 per cent of the dissolved oxygen.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Alloy Steels Here to Stay. ANON. Railway Age, **87**: 22, 1299–1300 (1929). Paper by Dr. W. M. BARR before the Western Railway Club at Chicago advises that alloy steels containing from 2 to 3 percent Ni, or 1.0 percent Cr with 0.15 percent V, have shown satisfactory results in sheets of locomotive fireboxes, by reducing cracking and corrosion. Experiments with tubes containing Ni are being made for comparison with tubes containing Cu and Mo. Cr-Ni steel forgings, heat-treated, have given good results in work parts. There is still much to be accomplished and research is recommended.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Floating Concrete Pipes Into Place. ANON. Railway Engineering and Maintenance, **25**: 12, 534–37, 1929. Specially designed collapsible bulkheads provided means for placing about 3,000 feet of 68-inch and 74-inch concrete pipe in place under the Charles River near Cambridge by the Boston and Maine RR. The pipes were floated into position and lowered as required. The special bulkhead was capable of ready assembly, could be removed from the submerged pipe without a diver, and could be used again. Photographs and plans are shown.—*R. C. Bardwell.*

Concrete Water Tanks Give Excellent Service. R. A. TANNER, Railway Engineering and Maintenance, **25**: 12, 541–44, 1929. The Duluth and Iron Range RR. developed improved design and erected four concrete water tanks of 100,600 gallons capacity between 1920 and 1923 which are giving good service. With minimum temperature 41°F. below zero, leakage developed was not considered sufficient to warrant waterproofing the later built tanks. Photos, plans, and formula are given.—*R. C. Bardwell.*

Stream-Flow Data—Its Collection and Use. H. B. KINNISON. Boston Soc. Civ. Eng. Jour., **17**: 171–248, May 1930. Stream-flow data are needed for the design, construction, and operation, not only of hydraulic works, but also of other structures erected on banks or on flood plains of rivers. Records should be started before the necessity arises and should be kept over a long

period of time. The longest records are too short to cover all extremes of flow, and the longer the records, the more dependable do they become. The study of stream-flow is a governmental function; neither private companies nor individuals can be expected to gather this information years in advance of the time of developments on the rivers. Approximtely twenty-five hundred gaging stations are being operated at the present time on the principal rivers and their tributaries in the United States. The selection of the gaging station control is of primary importance. Recording instruments are replacing the vertical, or inclined, staff type and chain gage. Float wells are now being built of concrete. The discharge for the peak of a flood can be computed after the flood has subsided, as was the case following the New England flood of November, 1927. It is possible to obtain measurements that are probably within two percent, and certainly within five percent, of the true discharge. A comparison of the current-meter method of determining discharge with the salt-velocity method was made at Bellow Falls, Vt. The mean difference for two measurements was 0.74 of 1 percent. Another check, made at the hydraulic laboratory of the Worcester Polytechnic Institute, was between measurements by a current-meter and those by a weir. The current meter measurements were smaller than the true weir discharge by an average deficiency of 1.16 percent. It is customary to estimate the discharge of non-gaged streams by comparison with records of flow on adjacent streams of similar characteristics that have gaging stations. The author attempted to compare records from two stations. He found that a prohibitive error could be introduced by estimating the discharge of one river from the discharge records of another. The mass curve of run-off shows the allowable rate of draft, which depends upon the accumulative flow of the stream, and also shows the amount of storage necessary to allow such a draft. A hydrograph covering the years of record shows at a glance the high and low periods of each year, the probable flow of the river for any period of the year, and by balancing the areas below a certain discharge with the area above this discharge it is possible to determine the dependable flow capable of being developed by use or storage. The duration curve is considered the best as a basis for the determination of rates of flow to be used in rules for rating rivers. A duration curve for the Connecticut River at Sutherland, Mass., for a 20-year period is shown. Duration curves are also used in determining the amount of storage or auxilary power needed to supply a constant demand. The author presents a tabulation of monthly mean discharge in second-feet per square mile for practically all river gaging stations in New England except those in the State of Maine.—*J. F. Pierce.*

NEW BOOKS

Arc-Welding Manual. 4th edition Schenectady, N. Y.: General Electric Co. 208 pp. From Chem. Abst., **24**: 327, January 20, 1930.—*R. E. Thompson.*

Electric Arc Welding. London, Ferry Lane, Walthamstow: Alloy Welding Processes. Free. Reviewed in Eng. Mining J., **128**: 741, 1929. From Chem. Abst., **24**: 579, February 10, 1930.—*R. E. Thompson.*

Les eaux potables et industrielles. Caractères et épuration. JULES CASTEELS. Paris: Ch. Béranger. 47 pp. F. 6. From Chem. Abst., **24**: 674, February 10, 1930.—*R. E. Thompson.*

Der Wasserbau. ARMIN SCHOKLITSCH. Ein Handbuch für Studium und Praxis. Bd. I. 484 pp. Bound, M. 52. Bd. II. 715 pp. M. 78. Munich: R. Oldenbourg. From Chem. Abst., **24**: 1919, April 20, 1930.—*R. E. Thompson*

The Flow of Water in Riveted Steel and Analogous Pipes. FRED C. SCOBEY. Paper; 6 x 9 inches; pp. 136. 30 cents; from Superintendent of Documents, Washington, D. C. From Eng. News-Rec., **104**: 495, March 20, 1930.—*R. E. Thompson.*

Trink- und Nutzwasser in der Deutschen Wirtschaft. WILLI VOLLBRECHT and RICH. STERNBERG-RAASCH. Berlin: Reimar Hobbing, S. W. 61. Cloth; 7 x 10 inches; pp. 302. 18 marks. Reviewed in Eng. News-Rec., **104**: 1025, June 19, 1930.—*R. E. Thompson.*

Der Wasserbau, II. ARMIN SCHOKLITSCH. Wien: Julius Springer. Bound; 8 x 11 inches; pp. 1,199. 78 Rm. Reviewed in Eng. News-Rec., **104**: 1025, June 19, 1930.—*R. E. Thompson.*

Selected Papers, Proceedings of the Fifth Annual Conference on Water Purification. Technical Bulletin No. 3: Engineering Experiment Station, May, 1930, West Virginia University, Morgantown, West Virginia, 123 pp. **Improving the Water Supplies of Mining Villages in Logan County.** E. B. CONNER. 9–13. Brief résumé of water supply and purification works installed in mining villages to reduce prevalence of typhoid fever, dysentery, flux, and other intestinal disturbances. **Recent Improvements in Dry Chemical Feeders and Chlorinating Equipment.** R. C. CLEMENT and E. P. JOHNSON. 14–16. Description of Wallace and Tiernan type "O" feeder and direct feed chlorinator. **Maintaining Chemical Balance to Resist Corrosion and its Application to a Recent Development in Lime Water Softening.** CHARLES P. HOOVER. 17–24. Benefits of film of $CaCO_3$ in preventing corrosion of pipe walls are explained. The formation of this film can be controlled through the adjustment of the $CaCO_3$ in solution. Similar principles have lead to the development of a process of water treatment by which the carbonate hardness may be reduced nearly to the theoretical limit: (1) Use from 25 to 50 p.p.m. of lime in excess of that theoretically required to combine with the free and half bound CO_2 and to precipitate the magnesium; (2) Settle out settleable precipitates; (3) Neutralize excess lime with CO_2 gas; (4) Mix with large excess of $CaCO_3$, sludge, or any other inert finely divided material; (5) Settle; and (6) Filter. Results of laboratory tests indicate that this is a practical process which does not require close supervision and which will eliminate some difficulties in filtering lime softened water. **The Use of Activated Carbon in Water Treatment,** LEWIS V. CARPENTER. 25–34. Experiments on the use of activated carbon made at West Virginia University during the summer of 1929 were directed: (1) to investigate the use of activated carbon for removing

chlorine, (2) to study the capacity of the carbon, (3) to study practical methods of regeneration, (4) to compare the result of this method with other approved methods, (5) to study the removal of phenols by activated carbon without chlorination, (6) to study other filtering materials for removal of tastes and odors. Experimental filters consisted of 50 mm. diameter glass tubes 5 feet long containing 12 inches of gravel and 30 inches of filtering material and were arranged for either upward or downward filtration at rates from 0 to 10 gallons per square foot per minute. Filtering materials tried were activated carbon (National Carbon Co.), hydrodarco (International Filter Co.), bituminous coal (Pennsylvania vein screened, between No. 4 and 20 mesh), domestic coke (crushed and screened), blast furnace slag, anthracite coal (crushed and screened), and ordinary charcoal. Preliminary tests indicated that all these substances, except activated carbons, had too low absorptive value, so that subsequent tests were limited to the two first named filtering materials. Tests of removal of chlorine indicated that chlorine present in water in amounts of 5 p.p.m. could be completely removed by filtration through activated carbon at rate of 10 gallons per square foot per minute. Author concludes that activated carbon filters should be installed after sand filters where turbidity is high. The carbon filtration should be upward at a rate between 6 and 8 gallons per square foot per minute, at which rates the loss of head will amount to less than 1 foot. Cost of activated carbon filtration is estimated not to exceed $2.00 per million gallons. **Experience at Charleston with Odor and Taste Control** LAWSON HAYES, 35–36. Phenol wastes in Elk River during winter of 1929 and 1930 caused obnoxious tastes and odors in water supply of Charleston. A two percent solution of $KMnO_4$ was fed into discharge from low lift pumps at a rate from 0.12 to 0.18 p.p.m. This was successful for a slight phenol taste but insufficient for a large amount. Subsequently, with the $KMnO_4$ applied as above, anhydrous ammonia was introduced into the settled water just prior to filtration at rate of 0.12 p.p.m. This treatment was successful in removing phenol tastes. Finally the application was limited to that of ammonia alone at the rate of 0.12 to 0.18 p.p.m. together with chlorine to maintain a residual of 0.12 to 0.13 p.p.m., allowing a period of contact of one and one-half minutes before the raw water entered the sedimentation basin. This ammonia-chlorine treatment has proven very successful. **The Use of Permanganate at the Weirton, West Virginia, City Water Works for the Correction of Chlorophenol Tastes.** L. L. LASHELL. 37–39. Permanganate applied at rates from 0.88 to 2.35 p.p.m. to effluent of settling basins has eliminated disagreeable odors and tastes resulting from combination of chlorine with phenol and other taste-producing water products in Ohio river waters. **Unusual Bacterial Conditions Encountered at Williamson Filtration Plant.** PAUL C. LAUX. 40–48. Experience at new filtration plant installed in 1927 has been that extremely high chlorine dosage and even prechlorination did not eliminate all gas-forming organisms. Conclusion is that when no gas formation is indicated after twenty-four hours, water is probably safe, but that bacteria producing gas after twenty-four hours, while not typically *B. Coli* are at least so closely allied as to merit some concern. **Improvements to the Bluefield Water Supply.** GEORGE D. NORCOM. 49–59. Detailed description of new impounding reservoir with storage of 127 million gallons. What con-

stitutes a Fair Return for a Water Utility? J. PAUL BLUNDON, 57–61. A brief discussion of elements to be considered in establishing fair value: (1) Original cost of construction plus yearly additions of permanent improvements. (2) Amount and market value of stocks and bonds. (3) Present cost of construction. (4) Probable earning capacity of the property. (5) Amount required to meet operating expenses. **First Year's Program of West Virginia State Water Commission.** E. S. TISDALE. 62–67. Brief résumé of problems confronting Commission and steps taken toward their solution. **Stream Pollution and Investigations in West Virginia.** L. KERMIT HERNDON. 68–74. Résumé of report on pollution survey of Cheat River basin. Summary of reconnaissance survey of tannery waste disposal methods in the State. **Treatment of Trade Wastes, a Necessary Feature of Stream Pollution Control.** W. W. HODGES. 75–83. General discussion of the growth and nature of manufacturing industries in West Virginia, with discussion of development of by-products and utilization of materials formerly wasted. Coöperative research has eliminated much waste of valuable material and reduced the extent of stream pollution in West Virginia. **Coöperation in Stream Pollution Control.** C. M. BAKER. 84–91. General discussion of relation of stream pollution to aquatic life and some fallacies current in the popular mind. **Stream Gauging Program in West Virginia.** WILLIAM KESSLER. 92–95. Summary of stream gauging work in West Virginia accompanied by map showing location of gauging stations. No data or records are given. **Some Interesting Results Obtained from a Study of the Water Distribution System at Parkersburg, West Virginia.** GEORGE HUBER and FRANCIS C. FOOTE. 96–102. Interesting disclosures resulting from a pitometer survey of the distribution system are described. **Laboratory Control Tests and their Practical Significance.** PERKINS BOYTON. 103–106. The value of laboratory tests in directing the application of chemicals and operation of filter plants on surface waters of rapidly fluctuating quality is discussed. **Difficulties Encountered in the Operation of Spencer Filtration Plant.** TOM CONNEL. 107–111. High color, high turbidity, and tastes and odors in a water from impounding reservoir draining a watershed of three quarters of a square mile requires close attention to operation of purification plant. **Sanitary Engineering in the Public Health Service in the Eastern United States and the National Parks.** ARTHUR P. MILLER. 112–120. Author discusses function of Public Health Service in control of drinking water on common carriers and in control of pollution in shell fish industry.—*R. L. McNamee.*

The Ammonia-Chlorine Treatment of Water. J. F. T. BERLINER, National Ammonia Company, N. Y. June, 1930. This method of treatment for taste prevention and sterilization is very fully covered. The introduction outlines historically use of chloramine, which is said to have been formulated in 1900, but not put into practical use until 1910–12, and summarizes the advantages and disadvantages of chloramine as compared with chlorine for treatment of water. Amongst the advantages claimed are (1) more effective bactericidal properties and the fact that treated water remains sterile for much longer periods; (2) elimination of objectionable tastes and odors; (3) reduction of 50 percent, or more, in amount of chlorine required for actual sterilization, (4)

effective sterilization maintained without excessive super-chlorination, resulting in economy in sterilization; and (5) freedom from taste and odor. It is stated that chloramine types of compounds are non-toxic to the human body and that there is no danger in the event of over-dosage. In dealing with the disadvantages, it is claimed that more equipment is necessary, but of such a simple nature that it cannot be considered of consequence. The chief disadvantage is that this type of treatment requires greater periods of contact to ensure sterility. The author states that "there is experimental evidence that in alkaline waters, or in waters buffered against acidity, the sterilizing rate is comparable, or even more rapid than, with chlorine." The nature and interaction of chloramine substances are discussed and comparative bactericidal properties of chlorine and chloramine are given. A splendid discussion of the mechanism of sterilization of water by chlorine and chloramine, is included which outlines the work and observations of many workers in all parts of the world. In dealing with the prevention of tastes and odors in water by means of chloramine, a synopsis is given of the subject to date together with the technique involved. Additional fields worthy of consideration include: (*A*) Treatment of water in swimming pools. (*B*) Sewage disposal. (*C*) Industrial slimes. (*D*) Dechlorination. (*E*) Food packing. These subjects are briefly covered. The extensive bibliography appended includes the work of 37 investigators.—*N. J. Howard.*

Hooker Electrochemical Company. Bulletin, 1930. Information of general interest and value to those using chlorine in treatment of water and sewage is included in this paper. Figures relative to the chemistry, solubility, combining proportions, and principal applications of chlorine in sanitation are given. Graphs are given of vapor pressure and other properties of liquid chlorine. Comparative cost figures of pulp bleaching using chlorine and lime are outlined; in this connection are found description and drawing of a lime hydration plant. Descriptions of direct chlorination, of chemical control tests for bleach liquors, and of preparation of reagents are of value. In dealing with bleaching powder, a solution table shows the degrees Baumé for the various concentrations of bleach, the corresponding specific gravities, and grams per liter of available chlorine.—*N. J. Howard.*

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